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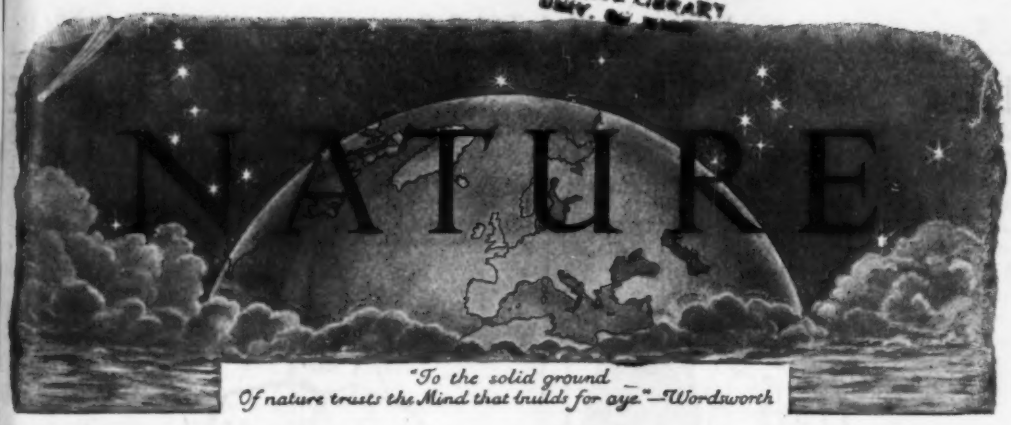

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NATURE

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PATENT LAW REFORM IN BRITAIN

THE second interim report of the Departmental Committee on the Patents and Designs Acts*, appointed in April 1944 by the President of the Board of Trade, deals with the two aspects of the patent system of Great Britain on which public interest has been mainly concentrated during the past few years, namely, the alleged abuse of monopoly rights under our patent system and the grievance concerning the grant of worthless patents and the legal procedure for the determination of patent rights. In its first interim report the Committee recommended a modification of the procedure for making applications for extension of the term of patents in cases where the patentee has suffered loss or damage as a consequence of the War, and its recommendation has been implemented in the Patents and Designs Act, 1946, which has just received the Royal Assent.

Recommendations in the second interim report are based on the results of an inquiry by the Committee in which it considered first the broad fundamental question, whether the maintenance of the patent system of Great Britain upon its present basis is justified as being still conducive to the attainment of those objects for which it was originally designed. The theory upon which the present system is based is that the opportunity of acquiring exclusive rights in an invention stimulates technical progress mainly in four ways : first, that it encourages research and invention ; secondly, that it induces an inventor to disclose his discoveries instead of keeping them as a trade secret ; thirdly, that it offers a reward for the expense of developing inventions to the stage at which they are commercially practicable ; and fourthly, that it provides an inducement to invest capital in new lines of production which might not appear profitable if many competing producers embarked on them simultaneously. The Committee expresses the opinion that the history of industrial development seems on the whole to have justified this theory, mainly because similar patent systems are in operation in almost all industrial countries, the only departure having been made by the Soviet Union. In the Soviet Union there is maintained, concurrently with the existence of a patent system of the usual type, an alternative method of encouraging and rewarding inventors by direct Government grants. The Committee is of opinion that this system is bound up with the particular economic system in which it operates, and has little bearing upon the problems of a country in which technical progress largely depends upon private initiative ; and it seems to us probable that this opinion will be generally endorsed. The technical progress of Great Britain has coincided with our patent system operating in conjunction with industrial research organisations financed by large companies, and long-term research arrangements supported by Government and private benevolence.

* Board of Trade. Patents and Designs Acts. Second Interim Report of the Departmental Committee. (Cmd. 6789.) Pp. 38. (London : H.M. Stationery Office, 1946.) 9d. net.

Several of those who had made public statements about the suppression of inventions were invited to give evidence, but did not accept the invitation; and the inquiry made by the Committee led to the opinion that the allegations of deliberate suppression of inventions and of other abuses of monopoly rights have been much exaggerated. The Committee favours the retention of the general frame of our patent system but recommends several important improvements. Under the existing provisions of the law relating to compulsory licensing of patents, an allegation of abuse of monopoly rights may be made to the Comptroller-General of the Patent Office, who determines the remedy most appropriate to the particular case—possibly a compulsory licence or even revocation of the patent. The Committee recommends some extension of these provisions so that facilities may be given for the grant of compulsory licences in cases where a more extended use of a patent could be made, even if no actual abuse of patent rights has taken place. In particular, where a patentee is exploiting a patent to the full extent of his ability but there are still other uses of the invention or potential demands for the patented article which remain undeveloped or unfulfilled, it would be in the public interest that an applicant who is in a position to open up a new field of manufacture should be at liberty to apply for a licence; equally, where the patentee is meeting the demand in the home market to the fullest extent but the export market is neglected or insufficiently supplied with the patented article.

Some of the evidence submitted to the Committee was directed towards advocating, as a remedy for the abuse of monopoly rights, that all patents when granted should be endorsed 'licences of right' in the same way as a particular patent may be endorsed if the patentee desires. If this proposal were adopted, it would reduce the patent grant to a right to receive royalties for the use of the patented invention, and the Committee considered how far this proposal would weaken the efficacy of our patent system in stimulating research, in promoting the disclosure and development of inventions, and in attracting investment for the working of inventions. It came to the conclusion that royalties would be an inadequate inducement to undertake heavy expenditure on development. It might be possible to fix royalties in such a way as to reimburse the patentee for the expense of development of the particular invention concerned; but much expense is incurred in following false trails, and it would be difficult to devise a system of royalties for making successful inventions carry the cost of useful but unremunerative research. On the evidence, the Committee does not recommend the adoption of the system of compulsory endorsing of all patents.

The proposed revision of the law concerning the grant of worthless patents and the legal procedure for the determination of patent rights is directed mainly to the second main public grievance. Under the existing law the Comptroller-General of the Patent Office has no power to refuse an application for a patent for an invention which obviously lacks inventive merit or, as it is termed, 'subject-matter'. The grant of patents for such inventions is, *prima facie*, contrary to public policy and also contrary to the purpose of the patent law, the object of which has always been to encourage genuine inventions without imposing undue restraint upon normal industrial development. The Patent Offices of the principal industrial countries, such as those of the United States, Germany, Sweden and Holland, have power to refuse applications for patents which, in their opinion, are lacking in subject-matter. There is evidence that patents granted by the patent offices of such countries have a higher validity value, and therefore a better chance of commercial exploitation, than patents granted in countries where the question of subject-matter is not considered. The Committee, with two members dissenting, recommends that the Comptroller-General should be given power to refuse applications for patents on the ground of lack of subject-matter, and we believe this recommendation will be generally approved.

On the legal procedure for determination of patent rights, the Committee's recommendations may receive criticism, though there will be much support for the view that there is need for some amendment. The commonest and most familiar ground of complaint is the high cost of patent litigation; but there is also undoubtedly a very general lack of confidence in the adequacy of the tribunal before which these patent cases come, and the feeling that the judges charged with the task of deciding patent actions have not the necessary scientific or technical knowledge or experience to assess the value of the expert evidence or to arrive at sound conclusions, where the invention in question involves the discussion of highly complex chemical, electrical, mechanical or physical matters. Those who have knowledge of High Court procedure are aware that it is a common occurrence in patent actions that a considerable time, possibly some days, is taken in instructing the judge in the elements of technology with which the invention is concerned, in order that the specification can be made intelligible to him, and the retention of highly paid counsel and experts makes a very serious addition to the total costs of such actions. The Committee has come to the conclusion that the principal reform necessary in the trial of patent actions is that they should come before a judge appointed, as at present, from members of the Bar, but also possessing sufficient technical or scientific qualifications to enable him to grasp the broad technical principles of such cases without extensive preliminary explanation or instruction. It recommends that two special judges, possessing technical or scientific qualifications and experience in patent litigation, should be appointed to hear all patent actions: either judge to be available to act as the patents appeal judge to hear appeals from decisions of the Comptroller-General. A scientific assistant should sit on all occasions with the special judge to try patent actions unless the judge, after hearing the parties, decides that such assistance is unnecessary.

As a further means of reducing the cost of patent litigation, the Committee recommends that the Comptroller-General of the Patent Office should be

authorized to try cases of alleged infringement where the parties agree to adopt this course. In such a case the Comptroller-General would be authorized to grant damages up to £1,000, but he would not have power to grant an injunction.

It is possible that some of the proposed procedure is open to criticism in detail; but if its broad outlines can be put into practice it will, in our opinion, go far to remedy long-recognized defects and to simplify and cheapen legal procedure in connexion with the patent system of Great Britain.

SCIENCE PRESENTS ITSELF

Mr. Tompkins Explores the Atom

By G. Gamow. Pp. x + 97. (London: Cambridge University Press, 1945.) 10*s.* 6*d.* net.

Electrons in Action

By James Stokley. (Whittlesey House Publication.) Pp. xi + 320 + 37 plates. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 18*s.*

Science in Progress

By Walter R. Miles, Selig Hecht, George D. Birkhoff, Henry Eyring, K. C. D. Hickman, Edwin J. Cohn, Detlev W. Bronk, Otto Loewi, Peter Debye, Isidore I. Rabi, and C. A. Elvehjem. Edited by George A. Baitsell. Fourth Series (Society of the Sigma Xi, National Lectureships 1943 and 1944). Pp. xvi + 331. (London: Oxford University Press, 1945.) 20*s.*

IF one may judge by the appearance of the bookshop windows and the bookstalls there is, at the moment, quite a minor boom in popular science in the publishing world. The part played by science in the Second World War and the publicity given to it in the Press have made science 'news' to an unprecedented degree, and authors and publishers seem to have guessed that the man in the street will want to know more about it. As might have been expected, in the circumstances, some of the resulting volumes bear every mark of having been hurriedly put together to catch the market—ephemera, for which no long-continued existence can be prophesied. In the meantime, the output of more authoritative and serious works has not slackened; three of these form the subject of this review. Science, we all know, is, or at any rate used to be, international; but a British reviewer may be pardoned a little quite friendly envy that all three books should have been written in the United States, and two of them published there. One would wish, out of sheer gratitude if for no other reason, that more could be done to put this form of 'lease-lend' into reverse.

Since Aristotle drew the distinction between 'productive science' and the science which 'exists for itself' each has had its devotees among men of science; and, no doubt, the same division of interest may be found among the readers of popular science books. It is to the latter class that Prof. Gamow addresses himself in "Mr. Tompkins Explores the Atom". One feels that Prof. Gamow loves his atoms—he has spent much of his life investigating them—as the devout lover worships his mistress; not for their utility, but for themselves alone. They are so fascinating that he wants to tell the world about them; hence this quite delightful little book.

This is not Mr. Tompkins' first appearance in scientific literature. Readers fortunate enough to have met this engaging little bank clerk in the early days of the War will scarcely have forgotten the fantastic adventures (induced by a rash decision to substitute the heady excitement of the physics lecture room for the more soothing solace of the cinema) he was fated to undergo in those strange quantum lands in which mathematical physicists live and move and have their being during working hours. Not only did they serve to while away the tedium and the terror of some anxious hours; they left, one may frankly confess it, a clearer picture of relativity and quantum theory than one had gathered from far more portentous expositions. In the present volume Mr. Tompkins, now happily married to the professor's daughter, Maud, is thereby exposed to still further draughts of the physical intoxicant. The three dreams which ensued, the three lectures by which they were stimulated, and a further lecture—thrown in as a make-weight so to speak—which Mr. Tompkins did not attend because his father-in-law advised him that it would be well over his head, make up the book.

In the first chapter Mrs. Tompkins, with Maxwell's demon for cicerone, is taken for a tour among the molecules of her husband's whisky and soda. In the second Mr. Tompkins, transformed into an electron, finds himself odd-man-out (or valency electron) on a sodium atom. Finding it rather lonely he transfers to the *M*-shell of a neighbouring chlorine atom, meets his partner of 'opposite spin', and has some high old times ("How am I going to explain this to Maud when I see her again?"), until he is ejected by a photon, to be finally annihilated by a savage positive electron. The final dream introduces us, and Mr. Tompkins, to the dear old gentleman (in appearance, if we may trust the author's sketch, a cross between old man Gepetto from "Pinocchio" and the late Lord Rutherford) who makes the atomic nuclei. The extra lecture deals with the Dirac theory of the positron, and so clear is the exposition that I see no reason why Mr. Tompkins should have been warned off it.

Sequels are notoriously apt to be disappointing; and it cannot truthfully be said that in the present volume Prof. Gamow quite recaptures the wild raptures of his earlier book. The genial humour, the flashes of insight, and the author's almost uncanny skill in making difficult matters plain are in no way diminished. The conceptions in terms of which modern science interprets atomic phenomena are, however, not so remote from everyday experience as those in which the mathematician interprets time and space; and so offer less scope to the author's imagination. Since the first atom bomb startled the world, the atom has become definitely 'news'. The manuscript of "Mr. Tompkins" was completed before Hiroshima put atoms in the headlines; there are no atom bombs in the book. One cannot imagine, however, that the book would have been essentially different had it been written three years later. It is the atom itself and not merely one of its more unpleasant potentialities which interests Prof. Gamow, and all the scientific background to the release of atomic energy is already in the text. The non-technical reader who wishes to appreciate something of this background cannot do better than accompany Mr. Tompkins in his explorations. He will not find a pleasanter, more authoritative or more illuminating guide.

In our enthusiasm for Prof. Gamow's book we have kept the practical man waiting for a rather unconscionable time. Mr. James Stokley's book will

make him ample amends. The title "Electrons in Action" is reminiscent of G. R. Harrison's admirable "Atoms in Action", but the resemblance goes little further. Apart from one or two concessions to the general reader in the early chapters, "Electrons in Action" is, in the main, a straightforward and competent account in moderately non-technical language of the whole science of electronic engineering as seen through American eyes. Two short chapters tell the reader all he needs to know about the electron itself; a further chapter describes the use of electron tubes as rectifiers, amplifiers and oscillators; the rest of the book is concerned with the applications of these, and other, electronic devices in industry, science, medicine and the arts including, of course, the art of war.

Considering that J. J. Thomson's original discovery of the electron will not celebrate its jubilee until next summer, it makes an impressive story. Broadcasting, television, fluorescent lighting, automatic industrial control, sound recording and production, and electron microscopy make a formidable list, even if we omit, as the author might have been well advised to do, X-rays (which, in point of fact, were discovered before electrons), and atomic energy, in the release of which electrons play no vital part. How could one have imagined that Thomson's curiosity as to the real nature of electricity should have been the foundation of several major industries, or that the original 'e/m tube', which one used to see lying around on a dusty shelf in the Cavendish Laboratory, should have begun to proliferate at a rate reminiscent of the herring and the puff-ball.

It says much for the restraint of the author that he has, in the main, confined himself to plain, unvarnished narrative. He has assumed that his prospective readers are already interested and wish to be instructed. This he proceeds to do. The underlying principles, and in some cases the details of the various techniques of electronics, are carefully described, and the reader who will work patiently through the book (it is not a volume to be skimmed) will find himself at the end with a useful general outline of the subject.

Mr. Stokley writes clearly and concisely, and has packed a good deal of information into his 309 pages of text. Some useful line diagrams, and a number of not very illuminating plates of the usual type supplied by commercial manufacturing corporations, illustrate the text. In getting up his brief, the author, who is not himself, we gather from the dust cover, a radio-engineer, has consulted the leading research workers of most of the great American corporations concerned with electronics, so that the information is both up to date and authoritative, so far as American developments are concerned. His contacts on the eastern side of the Atlantic, possibly owing to war conditions, seem to have been far fewer, and his general picture becomes thereby a little one-sided. Perhaps he may be able to rectify this in the next edition.

So far, in these latter days, has the pace of scientific discovery outstripped, not only growth of human morality, but also the capacity of the individual human mind, that men of science are beginning to find it impossible to keep abreast of new developments in other sciences or even (let us confess it) in their own. To remedy this unfortunate state of affairs, the "Society of the Sigma Xi" arranges annually a number of national lectures, in which specialists in one branch of science provide, for colleagues whose main interests lie in some other direction, authoritative surveys of important recent advances in their own speciality. These lectures, as many readers of *Nature* will remember, are collected from time to time into single volumes and published under the general title "Science in Progress". The present volume is the fourth of the series. It contains two articles on nerve impulses, one from the electrical, the other from the chemical, aspect, and a very interesting account of determinations of the smallest number of quanta required to stimulate the sensation of vision. On the chemical side we have accounts of recent work on the vitamin B complex, on the chemistry and separation of proteins, particularly those to be found in blood plasma, an article on modern vacuum chemistry with applications to the vitamin A industry, and on the more physical side a study of the distribution of energy in a molecular system, rates of reaction, and inhibition of luminescence. On the pure physics side we have a résumé of low-temperature production, and an article on molecular beams, together with a very charming and personal article on some aspects of mathematical physics from the pen of the late Prof. Birkhoff. As an innovation these are prefaced with a detailed, and possibly rather over-documented, account of the application of psychological methods in the American Army Air Force. All have been written by authorities of indisputable standing, who are actually concerned in the work which they describe.

Confronted with such a varied assortment, what is there for a reviewer to do? All the articles are obviously of high quality and importance. Omniscience alone could deal adequately with the whole of them, and a selection would express only the writer's particular interests and personal bias. The line of least resistance is to advise everyone who is interested in the progress of science to buy a copy for himself (the mere pleasure of handling once again a book so perfectly and beautifully produced is worth more than the modest twenty shillings at which it is priced) and to make his own selection. This we unhesitatingly do.

Two comments, however, can be made. In the first place, the choice of subjects to be included seems to have been somewhat restricted by the secrecy imposed on many branches of science by the exigencies of war. One can only hope for the sake of science itself—which flourishes best in the open—that some, if not all, of these official shackles may have been struck off before the fifth series of "Science in Progress" makes its appearance. In the second place, we would implore the editor of this very distinguished series to use whatever influence he may have with his contributors to induce them to remember the shortness of human life and the limitations of the human intellect, and have pity on our weakness. We are all interested in what they have to tell us, but few of us are adepts in their particular line of country. There is a tendency in every series of progress reports to become more and more technical, and thus less and less widely comprehensible, with each succeeding volume. Of the earlier volumes of the present series one felt that even the non-professional man of science might read them not only with profit but with pleasure. Now one is not so sure. In one or two of the articles in the present volume (it would be unfair to specify which) one has the feeling that the distinguished author has had in mind (perhaps unconsciously) colleagues in his own subject who have fallen in arrears with their reading owing to war-time preoccupations. There is a place for such articles—in the professional journals. Those of us, and we are not a few, who believe in the unity of science, and

strive to take an intelligent interest in the achievements of sciences not our own, have so welcomed the help we have received from previous volumes of "Science in Progress". May we hope that their successors will not prove too hard for our understanding. J. A. CROWTHER

THE INSIDE STORY OF THE SKULL

Anthropoid and Human Endocranial Casts

By Pierre Hirschler. Pp. ix + 150 + 11 plates. (Amsterdam: N. V. Noord-Hollandsche Uitgeversmij., 1942.) n.p.

THE calvarium of the mammalian skull is moulded over the brain which it contains. Hence a cast of the inside of the skull reproduces in a general way the form of the brain itself. It is for this reason that the study of endocranial casts assumes some importance in palæontology, and particularly in the palæontology of man and the other primates. But it has also been the subject of an intermittent controversy which bursts out afresh with every new discovery of fossil man or ape.

The point at issue is simply this—how much really reliable information regarding the shape and convolutional pattern of the brain is it in fact possible to obtain from an endocranial cast? The enthusiastic anatomist studying a fossil human skull of primitive type is naturally eager to glean all the information possible from his material, and the danger is that in his eagerness he may exceed the bounds of objectivity. There can be no doubt that this danger has not infrequently been sufficiently realized, even by anatomists of considerable repute; to such an extent, indeed, that the study of endocranial casts has tended in the recent past to degenerate into a sort of neo-phrenology, in spite of the fact that careful studies of endocranial casts of modern man and apes compared with the actual brains have already shown that the casts reproduce but little more than the general form and proportions of the brains.

From the Central Institute for Brain Research in Amsterdam there has now appeared a detailed and comprehensive work by Dr. P. Hirschler on anthropoid and human endocranial casts. This monograph (which should be thoroughly digested by students of human palæontology) is introduced by a critical review of the literature of the subject.

The author is particularly (and, we think, rightly) outspoken about those anatomists who appear to assume that every unevenness of the surface of an endocranial cast must be a fissural imprint; who claim that the relative size of a localized eminence can be taken to signify the possession of such mental faculties as the power of speech; or who ignore the influence of membranes, subarachnoid cisterns and blood vessels in the determination of irregularities on the cast surface. So far as the large anthropoid apes are concerned, Hirschler finds that endocranial casts show extremely few fissural markings which can be identified with certainty, a conclusion which is the more striking since the casts studied were made from skulls specially selected because the walls of the intracranial cavity showed well-marked juga cerebralia. In casts made from human skulls fissural markings can be identified on the orbital surface of the frontal lobe, near the anterior border of the frontal lobe, and on the temporal lobe. Elsewhere they are usually not present in any recognizable form, though as a very unusual rarity (possibly the result of a pathologically high intracranial pressure) they may be abnormally distinct.

When the critically minded demur at the confidence with which some anatomist claims to be able to identify on the endocranial cast of a fossil skull most of the details of the convolutional pattern of the brain, they are commonly met by two rejoinders. The first is that, while such details may not be discernible in the case of modern man and apes, for some unknown reason they happen to be much more distinct in the particular fossil under discussion; the second is that only after an intensive examination of the cast over a period of weeks and months—scrutinizing it from all angles of light and shade and palpating it repeatedly with the finger-tips—is it possible to express a confident opinion. But it must be clear that conclusions based on such subjective evidence can by themselves have little scientific value.

There seems only one way of securing a true interpretation of a fossil endocranial cast, and that is to circulate duplicates of the cast to a number of neurological anatomists and to request each to make an independent assessment with special reference to the identification of sulcal markings. By collating the results of such a group study, it may be possible to eliminate those variables which are clearly of subjective origin and to secure agreement on those identifications which may be taken as reasonably certain. W. E. LE GROS CLARK

ADVANCES IN MEDICINE

The March of Medicine

(New York Academy of Medicine Lectures to the Laity, No. 9.) Pp. xiv+121. (New York: Columbia University Press; London: Oxford University Press, 1945.) 11*s.* 6*d.* net.

THIS volume contains six lectures, and represents the ninth series of "Lectures to the Laity" which have been given under the auspices of the New York Academy of Medicine. These lectures are well known, and a number of small volumes have already been produced which are of great interest to professional men and laymen alike. The general title of the present series is "War and the Expanding Frontiers of Medicine". While the lectures are all good, some will be of greater interest than others to medical men and scientific men generally. The lecture by Dr. Strecker was evidently delivered with the purpose of boosting national morale, but the need did not necessarily disappear with the cessation of hostilities. Dr. King's lecture on food and civilization is thoughtful, and also practical in that he recommends action, not only against contaminated food but also against food of poor quality. He quotes illuminating figures which emphasize the great extent of malnutrition in the United States. Dr. MacLeod gives a straightforward and admirable account of the development of chemotherapy. Sir Gerald Campbell lets his humour play impishly around the alleged benefits of science to mankind. While he does not doubt that these have actually been benefits, he is sceptical regarding the ability of the human race to use them properly. The final lecture is by Lieut.-Colonel Thomas T. Mackie, who presents a really excellent review of the interrelation between wars and epidemics. The volume is up to the high standard set by its predecessors.

NUCLEAR ENERGETICS AND β-ACTIVITY*

By Prof. M. N. SAHA, F.R.S., and A. K. SAHA
University of Calcutta

EVER since the discovery by Joliot and Curie of the phenomenon of induced radioactivity in 1934, a very large number of radioactive nuclei, exceeding 450, has been prepared in the laboratory. In recent years, new types of radioactive nuclei have been obtained from fission of heavy nuclei like $_{92}U$, $_{90}Th$ and $_{91}Pa$, and possibly also of $_{93}Np$ and $_{94}Pu$; which have, however, not yet been released for publication. Extensive studies of the β^- and β^+ activities of these nuclei have been made in the various laboratories of the world. The data so far collected, though they have reached vast magnitudes, are by no means sufficient, but already they form a rather bewildering mass (for example, see tables by Seaborg[1]), reminding one of the vast collection of spectroscopical data, before the rise of the modern theories of the electron-structure of the atom reduced them to a few simple laws like Pauli's exclusion principle.

Z:	18	19	20	21
	A^{41}	K^{42}	Ca^{45}	Sc^{47}
	—	—	—	—

In addition to the nuclei like C^{14} which have been prepared in the laboratory, we have nuclei, mostly stable, occurring in Nature the number of which now reach nearly 250. In the case of nuclei derived from fission, the designation of a new isotope by mass is occasionally not quite unambiguous; indeed, this is a very acute problem for fission products.

Several attempts at a regularization of data have been made by previous workers, but here we shall refer to a chart prepared by Saha, Sarkar and Mukherjee[2], a section of which is shown in Fig. 1; the full chart is too large to be reproduced here. This is a synthesis of several charts already published by different authors. In this, the abscissa represents mass-number M, the ordinate represents the isotope number $I = N - Z$, which represents the excess of neutrons over protons in any nucleus. M ranges from 1 to 239, and I from -1 to about 54. The section of the chart reproduced here extends from $I = -1$ to $I = 8$. We have attempted to make the chart as up to date as possible. The parallel lines at 45°, henceforth to be called the Z-lines, represent the atomic number Z. Thus all isotopes of the element Z are to be found on the same Z-line. Each isotope is represented by a circle. Solid circles, ●, represent 'stable nuclei'. Hollow circles, ○, with an arrow pointing upwards represent β^+-(positron)-emitting nuclei. When the arrow points down, ♀, it indicates that the nucleus is β^--(electron)-emitting. Circles with arrow pointing both up and down, ⇕, indicate that the nucleus emits both negatrons and positrons, for example, Cu^{64}. ⓚ denotes that the nucleus decays by K-capture only. ⓚ denotes that the nucleus decays by K-capture as well as by positron-emission. ♀ denotes that the nucleus has been obtained in 'fission'; such nuclei are all β^--emitting. If any particular isotope has two different half-lives (isomers), both half-lives are given (compare Co^{62}). Saha, Sirkar and Mukherjee[3]

* Summary of a paper by M. N. Saha and A. K. Saha, "On Nuclear Energetics and β-Activity", *Trans. Nat. Inst. Sci. India*, **2**, 193 (1946).

gave the following rules of stability, some of which were previously known:

Rule 1: I is even.

When I is even, say 4, we get alternation of stable and β-active nuclei, as shown below:

Z:	15	16	17	18	19	20	21	22	23	24	25	26	27
	P^{34}	S^{36}	K^{39}	A^{40}	K	Ca^{44}	Sc^{46}	Ti^{48}	V^{50}	Cr^{52}	Mn^{54}	Fe^{56}	Co^{58}
	—	S	—	S	—	S	—	S	—	S	—	S	+

S denotes stable, — denotes negatron-emitting, + denotes positron-emitting.

Exceptions. There are certain exceptions: (*a*) He^6, B^{10}, C^{14} are β^--active, though both N and Z are even. (*b*) H^2, Li^6, B^{10}, N^{14} are stable, though both N and Z are odd. These rules have been given by Bethe and others.

Rule 2. I is odd, say 5: We have

22	23	24	25	26	27	28	29	30	31	32	33
Ti^{48}	V^{51}	Cr^{53}	Mn^{55}	Fe^{57}	Ca^{59}	Ni^{61}	Cu^{63}	Zn^{65}	Ga^{67}	Ge^{69}	As^{71}
Stable								+	+	+	+

(−) denotes negatron-emitting, (+) denotes positron-emitting.

The above is illustrative of all groups having I odd. If in any of the odd groups we arrange the nuclei in order of their mass numbers Z, we first get β^--emitting nuclei, then a succession of stable nuclei, which are followed by β^+-emitting nuclei.

These rules apply only to known nuclei. If in future it be possible to extend the series on both flanks, will the new nuclei follow these rules? We need not consider the nuclei with odd I because evidently rule 2 will continue to apply to them. Let us consider nuclei with I even: they may be illustrated by a typical group, say $I = 4$; we may think of the possibility of forming some day in the laboratory $_{12}Mg^{28}$ and $_{14}Si^{32}$, on the left flank, and $_{32}Ge^{68}$, $_{34}Se^{72}$, on the right flank, though these are at present unknown. Will they be stable, or unstable like $_6C^{14}$ with a long life?

An explanation to these rules, and a clue to the energetics of β-emission, is afforded in a general way if we write out the formula for mass-defect of nuclei in the form $\Delta M(Z,A) = \varphi(Z,A) + \chi(Z,A)$, where $\varphi(Z,A)$ is the spin-independent part, which is given by one of the various mass-defect formulæ due to Weizsäcker, Bethe or Wigner. We have taken, for the sake of simplicity, the Weizsäcker–Bethe form

$$\varphi(Z,A) = \alpha A - \beta \frac{I^2}{A} - \gamma A^{2/3} - \frac{\delta Z^2}{A^{1/3}} \quad . \quad (1)$$

with Bethe's values of the constants α, β, γ, δ. These values were based on older data on masses of nuclei, but probably the newer data will give better values. But these have not been available to us. We have sometimes adjusted the value of β, but this is an unsatisfactory procedure from the theoretical point of view. The Weizsäcker–Bethe formula holds only for Z even, N even, for which the nuclear spin $i = 0$, and the spin-dependent term $\chi(Z,A) = 0$.

The Spin-dependent Term

When I is even and Z odd, N odd, for example, in $_7N^{14}$, we have found uniformly that $\chi(Z,A)$ is negative and of the order of a few million electron-volts. For odd I, no general principle has yet been found.

From the general mass-defect formula, expressions for the energy-release in β-transitions have been worked out. Let E^- be total energy-release in a

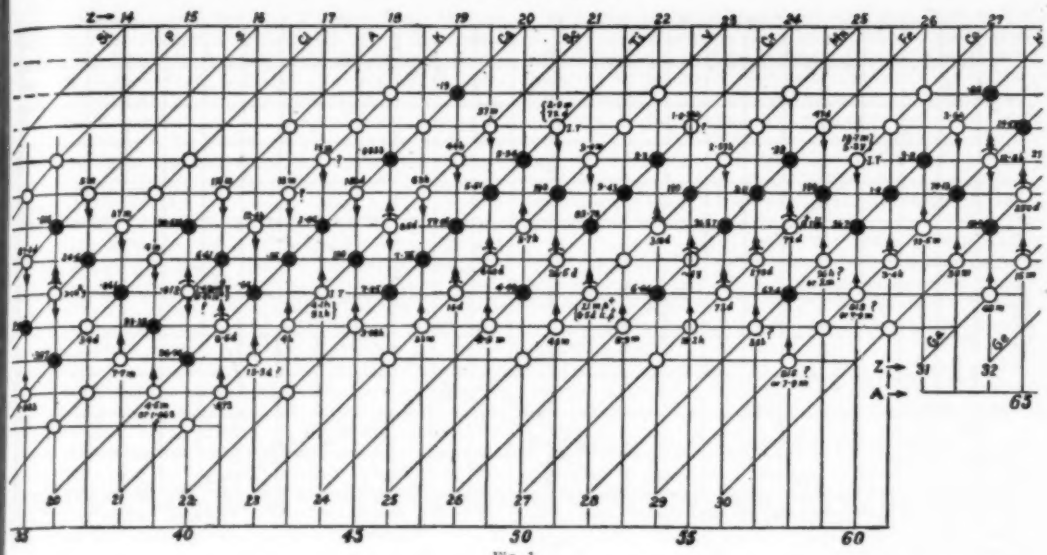

Fig. 1

β^--transition in which a nucleus ${}_zM^A$ changes to ${}_{z+1}M^A$; then it can be easily shown that

$$E^- = A^- + \chi(Z+1, A) - \chi(Z,A),$$

where

$$A^- = 0{\cdot}766 + \frac{4\beta(I-1)}{A} - \frac{\delta(A-I+1)}{A^{1/3}}$$

in Mev. . . (2)

The χ-functions may be multi-valued, corresponding to the different nuclear levels of both parent and daughter nuclei. For β^+-emission, let us denote by E^+ the total energy-release in a β^+-transition when the nucleus ${}_zM^A$ changes to ${}_{z-1}M^A$. It can be easily shown that

$$E^+ = A^+ + \chi(Z-1,A) - \chi(Z,A),$$

where A^+ is the spin-independent part given by

$$A^+ = -1{\cdot}788 - \frac{4\beta(I+1)}{A} + \frac{\delta(A-I-1)}{A^{1/3}} . \quad (3)$$

For K-capture, the energy E^K released in the process, which is taken to be carried by the neutrino, is given by

$$E^K = E^+ + mc^2\{1 + \sqrt{1-\alpha^2 Z^2}\} \simeq E^+ + 2mc^2 . \quad (4)$$

Energy-Release

In cases where the β-transitions are of a simple allowed type, the energy-release is simply equivalent to the end-energy of the β-spectrum, for in general in such cases no γ-rays are emitted. Where such is not the case, but β-rays are of the forbidden type, for example, in Na^{24}, and γ-rays are also emitted, the task of finding the energy-release from the β- and γ-radiations emitted is a rather difficult one, and every case has to be dealt with separately. A typical case is afforded by Na^{24}, which has been discussed by Kruger and Ogle[3] and by Maier-Leibnitz[4]. In such cases we have to examine with great care the decay scheme of the β-transitions as given by different authors; but this is not easy, for the data are very often contradictory.

According to these formulæ, the values of E^-, E^+ and E^K depend on I and A, and on the spin-dependent terms $\chi(Z,A)$. The classification of nuclei according to I-values is therefore justified.

It is obvious that a nucleus is stable with respect to β^--emission when E^- is negative, and with respect to β^+-emission when E^+ is negative. But for the right-hand nuclei of the nuclear chart, even when E^+ is negative, the nuclei may decay by K-capture, provided E^K is greater than 0, or E^+ is greater than $-2mc^2$, which is approximately 1 Mev. The line of stability is therefore depressed by -1 Mev. below the zero-line, for the right-hand nuclei.

The operation of these rules is best illustrated by taking one or two typical examples for I odd and I even separately. We first take I odd, and choose the group $I = 3$. This is illustrated in Fig. 2. Here the abscissa represents the mass number M, the ordinate represents A^- and A^+, calculated from formulæ (2), (3). The known nuclei extend from O^{19} to Ga^{65}. If the χ-terms contributed nothing to E^- or E^+, all nuclei for which A^--values were below the zero-line, and A^+-values below the line (-1) would have been stable, namely, from S^{33} to Ti^{47}, and the energy-release would be given by the values of A^- and A^+ against each mass number.

Actually we have all nuclei from Cl^{37} to Ti^{47} stable, with the exception of A^{39}, about which we have extremely meagre data and probably wrong information. S^{35} is very nearly stable—it has a long life of 87·5 days. We have for S^{35},

$$E^- = A^- + \chi(18, 35) - \chi(17, 35).$$

The A^- is below the zero line, $\chi(18, 35) - \chi(17, 35)$ is evidently positive, and these terms take E^- slightly above the zero line. E^- is only 0·103 Mev. according to the measurements of one of us (A. K. Saha), but if there is a γ-ray emitted by S^{35} in cascade, as claimed by Giebert *et al.*[5], E^- is 0·233 Mev.

The energy-release in the case of β^--active and β^+-active nuclei generally follows the A^- and A^+-curves. The ringed points give the actual values, wherever available. On the right-hand side, however, data are generally very uncertain; but whatever is available appears to be in agreement. V^{49} is nearly

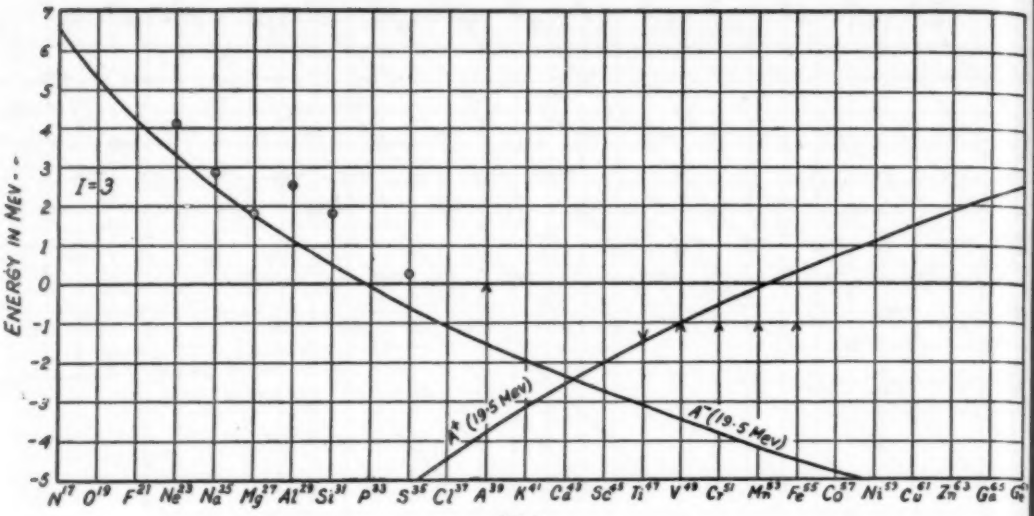

Fig. 2

stable, decaying only by K-capture and having a long life of 600 days. As we proceed outwards the nuclei release progressively larger amounts of energy, and become short-lived. When E is large, intermediate levels are formed and the energy-release takes place through β-rays and γ-rays emitted in cascade. As mentioned earlier, the data on such cases have to be carefully sifted, and most are yet uncertain.

When I is even, we can place the nuclei in two categories :

1. *Even-even nuclei* (N even, Z even). For such nuclei we have

$$E^- = A^- + \chi(Z+1, A) < A^-,$$
$$E^+ = A^+ + \chi(Z-1, A) < A^+ \quad . \quad (5)$$

for $\chi(Z,A) = 0$, when Z, N are both even, and $\chi(Z,A)$ is uniformly negative when Z and N are both odd. Hence Z being even here $\chi(Z+1, A) < 0$.

2. *Odd-odd nuclei* (N odd, Z odd). For such nuclei we have, since Z is odd,

$$E^- = A^- - \chi(Z, A) > A^-,$$
$$E^+ = A^+ - \chi(Z, A) > A^+ \quad . \quad (6)$$

The operation of these rules is illustrated by the case $I = 2$.

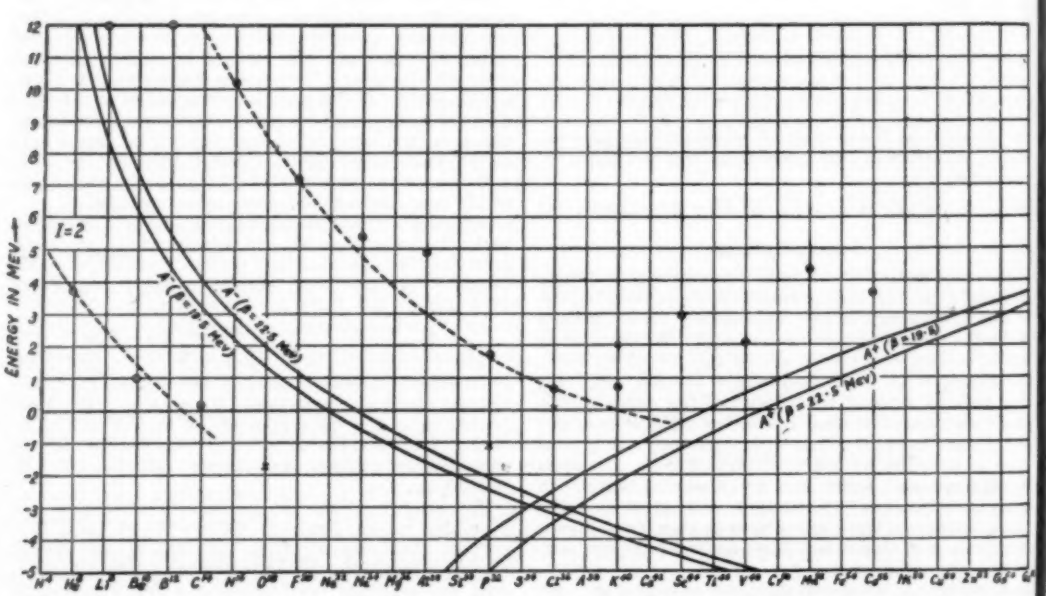

Fig. 3

The known nuclei for $I = 2$ range from He^6 to Ga^{64} and the operation of rules (2), (3) is illustrated in Fig. 3. The A^-- and A^+-curves have been drawn for two values of β, namely, 19·5 and 22·5 Mev. The first is Bethe's value, the second is a trial value. The ringed points give us the observed values of energy-release. It shows that $\chi(Z,A)$ is negative whenever Z is odd and is of the order of 3–5 Mev. The dotted curve has been drawn for β^--emitting nuclei with Z odd. For even-even nuclei, such a curve would be parallel to the A^--curve, but according to (5), as much below it, roughly, as the odd-odd nuclei values are above. Only a section of it passing through the points He^6, Be^{10} and C^{14} is shown. Here the $|\chi(Z,A)|$ terms are smaller than $|A^-|$, which is large on account of small values of M, the mass number, and hence the nuclei are negatron-emitting, though both Z and N are even; but the value of E^- is far smaller than those of contiguous odd-odd nuclei like B^{12} or N^{16}, where the two terms are additive. The curves give a rough indication as to the value of energy-release in a β^--emission. From O^{18} the A^--values become smaller as the atomic mass is large, though χ's continue to be of the same order and all even-even nuclei have E^- negative and therefore the nuclei are stable.

On the right-hand side, the ringed dots show the energy-release wherever known. The stability of even-even nuclei up to Ni^{58} is easily explained. The next even-even nuclei like Zn^{62} or Ge^{66} will prove to be either stable or decaying by K-capture with a long life.

Cl^{36} and K^{40}, which are in the middle of the group, are especially interesting. Cl^{36}, like Cu^{64}, has been found (Grahame and Walke[6]) to decay both by β^--emission to A^{36} as well as by K-capture to S^{36}. K^{40}, which occurs naturally, is similar, as it decays by negatron emission to Ca^{40}, and by K-capture, but probably also by positron emission to A^{40}, as several investigators have found, but its spectrum requires re-investigation. Positron emission by K^{40} is indicated by the annihilation radiation of 0·5 Mev., found by Klemperer.

It has been found for other groups that all nuclei which decay by simultaneous emission of negatrons on one hand, and positrons or K-capture on the other hand, like Cu^{64}, occur round about the points where the A^--curves cut the A^+-curves.

So far, we have examined the data available for nuclei belonging to the groups $I = -1$ to $I = 6$, and in more recent work by A. K. Saha and S. Ghosal, the method has been extended from $I = 7$ to $I = 20$. We have generally confirmed that the stability of nuclei, and the energetics of β-emissions, can be explained in the same general way; but it is not so easy to deal with level-formations in the nucleus. Probably the agreement will be far better when a more accurate mass-defect formula for even-even stable nuclei is available. A few important deductions arising out of the present investigation may be noted.

(*a*) Li^5 is expected to be a nucleus having a long life of several years, and decaying by K-capture to He^5, which should be stable.

(*b*) A^{39}, reported as a β^--nucleus with a life of 4 min., is a glaring anomaly. A^{39} is expected to be a long-lived nucleus decaying by K-capture to K^{39}.

(*c*) Even-even nuclei may not always be stable, if the nucleus is a bit off the main line of stability. Thus Ti^{44}, Cr^{48}, etc.; if they could be prepared, they would be found, like C^{14}, to be long-lived products, decaying in these cases by K-capture.

(*d*) It is probable that Ca^{48}, stated by Nier to be a rare stable isotope of calcium with a frequency of 0·2 per cent, is illusory, like Co^{57}, which was once believed to be stable, but was predicted by us to be unstable. This prediction has been confirmed; recently I. Curie[7] has independently come to the view that a stable Ca^{48} does not exist. This nucleus, and Ti^{52}, Cr^{56}, Fe^{60}, if they could be made, would be found unstable, decaying like C^{14} with the emission of slow β^--rays. The first stable nucleus in the group $I = 4$ should be Ni^{64}.

(*e*) The radioactive nuclei V^{50}, Mn^{54}, Co^{58} should decay with both β^+ and β^- emissions and K-capture, but only β^+-emission and K-capture activity have been reported so far. If they are found not to emit β^--rays, a fundamental difficulty arises in the theory of β-emission.

(*f*) The spin-dependent part of the nuclear binding energy, namely, $\chi(Z,A)$ is found generally to be of the order of a few million electron volts, while according to classical theory it should be $\simeq \frac{Zev}{cr^2}\mu_K$, where Z is number of charges in the nucleus, v is the velocity of a nucleon inside in the nucleus, and μ_K is the nuclear magnetic moment. Making plausible assumptions about these quantities, we find that $\chi(Z,A)$ is of the order of about 10–20 kilovolts. This shows that we have to apply some type of meson theory to find out the right order of value of the spin-dependent part of the nuclear binding energy. Actually, D. Bose has deduced the right order of value for $\chi(Z,A)$ using the vector meson theory of Kemmer, but as theories of meson field, as Louis de Broglie has said, are not yet definitive, this point has not been pursued further.

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DIELECTRIC PROPERTIES OF RAW COTTON

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Cotton Research Board, Egypt

SOME evaluation of the dielectric properties of cotton at various moisture contents was needed because of a project to use thermionic heating on the eighty ovens of the Alexandria Testing House. The directly usable facts having been obtained, it seemed worth while to extend the inquiry by measuring the dielectric 'constant' in fields which traversed the hair lengthways, instead of the usual transverse direction. Facilities for preparation of such material were freely available from our spinning test mill. Results show that the values are twice as large lengthways, the 'K' of cotton dried at 100° C. being about six longitudinally and three transversely. It is not surprising that such a structure as the cellulose wall of the cotton hair[1] should be electrically anisotropic, and the results obtained have some interest for interpretation of the properties of all fibrous materials, including wood.

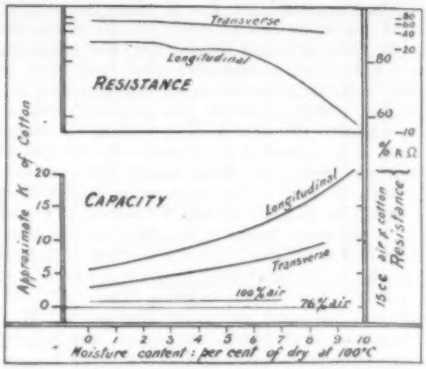
The cotton was packed between plates of stiff perforated duralumin, forming a condenser enclosed in a casing through which air could be circulated by

a pump, the assembly being light enough to weigh on a chemical balance after sealing. Capacity was measured by subtraction on a calibrated variable condenser in a rejector circuit loosely coupled to an oscillator, crystal-controlled at 1,755 kc. Resonance was indicated by a thermionic voltmeter with a device for indicating the mean of the two flanks of the resonance curve automatically. Adjustments for zero and range on the millimeter enabled the height of the resonance curve to be read off as a percentage of its height when the circuit was not loaded; this percentage was calibrated in terms of the equivalent shunt resistance, henceforth described as the 'resistance' of the cotton. The capacities measured ranged from 5 to 1,000 $\mu\mu$F., and were read to $\frac{1}{4}$ $\mu\mu$F. below the 250 $\mu\mu$F. level. The capacity of any condenser in air determined by calculation was checked experimentally by subtracting 'parasitic capacities' due to bolts, casing, leads, etc., or by replacement of air by paraffin wax.

Cotton is an inconvenient material. Most of the condensers used had two external earth plates, the live plate being registered in position between them and left floating between two layers of cotton. The whole condenser was compressed in a vice, and held together by small bolts passing through clearance holes in the live plate, after which the registering pins were removed. Densities of about 50/50 by volume were the greatest thus obtainable. Inter-electrode distances ranging from 5 to 1 mm. were chiefly used. This distance could be changed with the cotton inside by altering the fourteen clamping bolts, and in this way the dielectric constant could be computed. The value of 'd' at any adjustment was obtained by averaging dial micrometer readings of the total thickness of the condenser. This 'variable-d' method could not be used for the longitudinal field, for which the hairs had to be cut to a fixed length, fitting exactly between the plates.

The intransigence of air-dry cotton for these packing operations can be overcome by soaking with water, either boiling or at reduced pressure. A pack of ten million hairs on end, each 4·8 mm. long, inside a circle of 7 cm. diameter, was thus obtained with no other support than a thin encircling band of muslin varnished with 'Perspex'. A bundle of six draw-frame slivers (0·26 hank) was dragged through a series of 'Perspex' washers, each 4·7 mm. thick, with a 5·22 mm. hole; a safety-razor blade between the washers parted off one from another, leaving each hole filled tightly with a plug of short hairs. When all the hair had been displaced by water these plugs could be pushed out and handled for a short time before they began to expand, and a hundred of them were thus packed honeycomb fashion on the earth plate of a condenser, the live plate being fixed over them in contact, registered on three small 'Perspex' pillars, and the whole assembly dried to constant weight in the usual air-stream. After completing the measurements the same condenser was repacked with the same weight of cotton (to 1 per cent) inside the same volume, but with draw-frame sliver of hairs parallel to the plates, and the readings repeated. The latter pack contained approximately 1·7 million complete hairs, the cotton being Karnak Fully Good of 0·00137 mgm. hair weight, and 29 mm. mean length. The results in Fig. 1 show a remarkable contrast.

For the longitudinal field the picture is clear; we are dealing with ten million little condensers containing cellulose, in parallel with similar ones



Same condenser, same weights and volumes (cotton 24%; air 76% by volume).
Fig. 1

containing air, and the capacity follows the relative volumes, or plate areas, occupied by each. So the longitudinal dielectric constant in the dry condition is 6, without ambiguity.

That the values for a transverse field appeared to be just half of this was at first regarded as fictitious and due merely to a form-factor. Tests with strips of celluloid seemed to confirm this; strips on edge had nearly double the capacity of strips packed horizontally; the series formula for alternating layers of different dielectric seemed to apply, and the real K then was about the same. But if this formula holds we cannot account for the rise of capacity with additional moisture content, such rise being trivial in a loosely packed condenser. The analogy appears to be rather with a mixture of gases, the cotton and the air each contributing its volume-proportionate share to the total, just as in the longitudinal field. On this computation the transverse dielectric constant of dry cotton is 3 only, as plotted, and the rise of capacity with additional moisture is predictable. That each increment of moisture should raise K more than its predecessor is quite reasonable. The transverse curve is shown in more detail in Fig. 2, which shows a rather lower K at 7 per cent moisture than is shown by Fig. 1. The former is more likely to

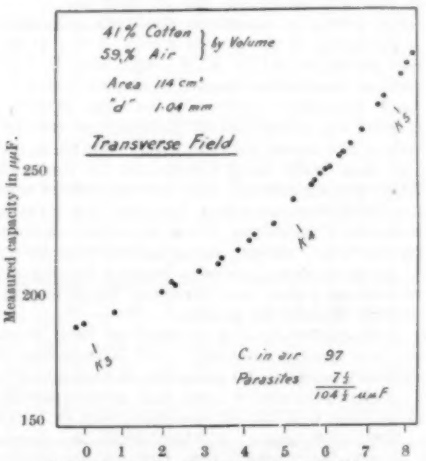


Fig. 2

be correct, because it tallies with results from 'variable-d' measurements, and the small values handled in Fig. 1 were designed for exact comparison, rather than for absolute measure.

For practical application in thermionic heating the prediction of capacity which will result from hand-packing a given weight of cotton into a known volume of inter-electrode space must be rather approximate. The hairs are variously oriented and neither curve of Fig. 1 will apply. From simple geometrical considerations it is evident that the transverse field result will be closely applicable with tight compression, and an average of the two if the hairs were fluffily oriented in all directions. Neither condition would be met in testing-house practice. Rough trials indicate that it should suffice to take the transverse field value and raise it by 10 per cent.

The above results can only be considered as fair approximations, for the sources of error with cotton are various. The volume of dry cotton is calculated from the weight on the value accepted, of 1·55 sp.gr. But we know that the cotton swells as it takes up moisture[2]; How and when does this appreciably affect our computation? One may even ask, What is cotton?

Another error had to be compromised, namely, the lag of cotton in attaining moisture equilibrium. Slater's work[3] showed that three days should elapse before testing after any change of moisture content. We minimized this by re-circulating air through the perforations of the condenser, at ten litres a minute on an Austen diaphragm pump. Even so, though successive results plot smoothly during a day's work there may be a shift during the night, the magnitude of which varies with the packing, with the zigzag of the air-flow paths, and so on. It is rarely large enough to require correction by a final plotting of the curve through these stabilized points; thus, Fig. 2 is plotted from raw data.

A cognate source of error is the change of cotton temperature when gaining or losing water. With the condenser and a wash-bottle of water both nominally at room temperature, the cotton during recirculation may presently cease to take up any more water, or even lose water back to the bottle, as shown by a capacity-fall or by weighing. Changes in small steps mitigate this, but precision can only be got by three-day waits between changes.

There is, of course, no hysteresis loop in Fig. 2, because the actual weight of the cotton-water complex is plotted against the capacity, though the equilibrium lag can sometimes simulate it.

Particular attention was directed to the known phase boundaries of the relation between cotton-properties and moisture content, shown by the studies of Slater and Goshawk to exist in regions corresponding roughly to 3, 5 and 10 per cent moisture content. The present results are not good enough to provide a definite conclusion, but an anomaly in resistance was twice shown by longitudinal tests in the 3 per cent region, where Slater's longitudinal D.C. resistance curve is sharply bent; there is definite acceleration of the curves for both resistance and capacity in the 5 per cent region; the capacity curve is straight up to 3 per cent, as exemplified in Fig. 2. The 10 per cent region has only been roughly examined; a series condenser used to extend the range makes the resonance curve less blunt and more readable.

A point of interest in Fig. 2 is that the curve passes smoothly down through drying at 100° C. to drying at 115° C. More important is the fact that though the rise of capacity with moisture content accelerates, its rate of rise nowhere approaches the magnitude which free water with a K of 81 actually produced in the apparatus used. Up to 11 per cent moisture we are certainly not dealing with free water, but the stage when it appears should be interesting to examine.

Some determinations on wood were made by packing the condenser used for Fig. 1 with a hundred small wood cubes, arranged with the grain running from plate to plate (longitudinal field) and again with grain parallel to the plates (transverse field). A ratio of 16/10 in capacity was found. It would seem that the anisotropy is a property of secondary cellulose structures in general.

The encased and perforated condensers lent themselves to rough parallel determinations of the relative humidity of the air recirculating through them, using apparatus previously described[4]; also, of the obstruction to air-flow offered by the cotton as it swelled with water-intake, by putting an inclined differential alcohol manometer on the two sides of the casing. The results agreed with expectation, and a fuller investigation might include measurement of the cotton temperature by incorporating a thermo-junction in the live plate. Capacity, resistance, humidity, permeability and temperature could all be measured together.

My thanks are due to my colleagues, H. A. Hancock, D. S. Gracie and F. Khalil for all facilities.

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SHRINKAGE AND CRACKING OF CEMENTIVE MATERIALS

THE symposium organised by the Roads and Building Materials Group of the Society of Chemical Industry and held at the Royal Institution on May 8 was the first result of a suggestion made by Prof. J. D. Bernal, chairman of the Scientific Advisory Committee of the Ministry of Works, that there was need for more discussion of the fundamental problems associated with building. The subject chosen, the shrinkage and cracking of cementive materials, is not only one of major importance to all building technologists, but it also throws up many problems which, it is hoped, may engage the attention of the worker in pure science. The symposium was organised in collaboration with the Ministry of Works, and, in opening it, Sir Reginald Stradling, chief scientific adviser to the Ministry, pointed out that the problem of the dimensional stability of materials is a most important subject, and one which has engaged the attention of workers in this field over the last twenty years. Nevertheless, much still remains to be done, and he hoped that the contributions made to the symposium would lead to a clearer understanding of the nature of the problems.

Two of the papers, one by M. R. L'Hermite, director of the Laboratoires du Bâtiment et des Travaux Publics, Paris, and the other by Dr. F. M. Lea and Mr. C. R. Lee of the Building Research Station at Watford, dealt with problems of concrete, the former discussing recent studies made in the author's laboratory on the shrinkage of concrete, and the latter

giving a general survey of the main facts relating to shrinkage and creep phenomena and of the theories of their causes.

It is well known that, even in the absence of applied loads, concrete is liable to undergo volume change. Apart from thermal effects and other minor causes, these volume changes are caused by alterations in the moisture content of the material, and restraint of them leads to the development of stress and, in the limit, to cracking. Thus, when concrete changes from a saturated to a completely dry condition, the contraction occurring is approximately the same as that which would be calculated, on the usual simplifying assumptions, as arising from an applied compressive stress of the order of 800 lb. per sq in. Under complete restraint, therefore, the stresses which arise are of the same order as the normal permissible design compressive stress and greater than the ultimate tensile stress of the concrete.

Much can be done to reduce the risk of cracking; but nevertheless, cracking of concrete is of common occurrence and has come to be regarded as an annoying, and somewhat unpredictable, phenomenon. Rational design in concrete is affected by the fact that the stress/strain ratio under applied load is not constant, but varies with the time that the load has been applied. Thus, on application of a load, concrete exhibits an immediate elastic strain, and then a further progressive strain or creep which continues for years, and which may become several times greater than the original immediate strain. Creep will often act in such a way as to relieve the effect of shrinkage, and both are obviously of major importance in design. A typical value for the drying shrinkage of concrete is about 0·05 per cent, though this may vary considerably, according to the nature of the concrete and the conditions to which it is exposed. The shrinkage of concrete on first drying is in part irreversible; on subsequent cycles of wetting and drying a somewhat lesser movement occurs, but this is substantially reversible. Most measurements of shrinkage have been done on unrestrained specimens, but it is the stresses set up by restrained shrinkage rather than the magnitude of the free shrinkage which are of prime importance in practice.

Shrinkage of concrete has been variously attributed to capillary condensation, surface adsorption, solid solution or hydration phenomena. In the first two, attention is primarily directed to the pore structure of the mass, while in the latter two, it is the nature of the binding agent which is regarded as the dominating factor. Elaborating the capillary condensation theory, M. L'Hermite referred to recent studies with the electron microscope made in the United States, from which it appears that hydrated cement consists essentially of a matrix of interlaced fibrous crystals, in which are embedded other crystals of a more massive plate-like shape. Cohesion of the cement is to be attributed to the presence of these fibrous crystals, but their very large surface area must give rise to capillary and surface phenomena which, in M. L'Hermite's view, lie at the root of the dimensional changes of concrete with change in moisture content. Elaborating the capillary condensation theory, M. L'Hermite calculates the equivalent compressive stress induced in solids by water held in capillaries under tension and arrives at an expression relating shrinkage to the volume compressibility, relative humidity and combined water content of the concrete, which shows moderate agreement with the experimental results. As was pointed out, however, in other papers, there are numerous objections to capillary condensation as an explanation of volume change, and it is doubtful if it can at best be more than one of a number of factors concerned. M. L'Hermite also discussed the internal stresses set up in concrete by shrinkage, and in particular the stress in the reinforcement. From a consideration of the stresses in the concrete and the compression in the reinforcement, he is able to calculate the extent of cracking and the time at which it will occur.

Creep of concrete differs from plastic flow in metals in that it occurs down to the lowest stresses at which measurements are possible. For stresses within normal working ranges, creep for any one concrete is approximately proportional to the applied stress. The real distinction between shrinkage and creep in concrete is, however, not clear, for, in the case of specimens stored in air and undergoing creep tests, drying is usually occurring at the same time, and, with it, drying-shrinkage. The distinction between the two depends, therefore, on the assumption that they can be regarded as independent, and that creep can be measured as the increased deformation of a loaded specimen as compared with one which is not loaded but is maintained under otherwise similar conditions. Creep of concrete under water is not, of course, complicated by this shrinkage, though there is some slight expansion caused by further hydration of the cement. So far as all experimental evidence goes, creep is largely irrecoverable, but it has been argued that this is due to ageing effects in the concrete while under the test. Creep has been variously regarded as an irreversible phenomenon, as a delayed elastic phenomenon, and as such theoretically reversible, or as merely the consequence of non-uniform shrinkage. Much more data on the effect of the moisture content of concrete and of temperature on creep are vital to any theory.

In his paper on "The Swelling and Shrinkage of Porous Materials and the Role of Surface Forces in Determining the Technical Strength of Artefact Materials", Dr. D. H. Bangham pointed out that the common observation that a liquid tends to form drops means that the idea of a liquid possessing surface energy is easy to grasp; but it is not so easily realized that solids also have surface energy. Nevertheless, the surface tension of solids is many times greater than that of liquids. The reason why a powder does not coalesce into a solid mass is that the areas of contact between the grains are small, and the mutual pull of the particles is resisted by the rigidity of the material. The coalescence of solids thus depends partly on the magnitude of the surface forces and partly on the resistance to deformation. This, for example, explains why particles of wax with a low surface tension cohere together more strongly than particles of diamond with a high surface tension.

Meehan was the first to demonstrate in 1927 the swelling of charcoal when it absorbs gases and vapours. The detailed studies which have been made by Bangham and his collaborators have shown that the expansion is proportional to the surface-energy lowering which accompanies adsorption. This result is intelligible if it is remembered that the original size of the solid charcoal represents a compromise or balance between two opposing sets of forces: (1) the surface forces which, if left to themselves, would aggregate the material into a sphere of zero porosity; and (2) the elastic forces which impart rigidity to the material. The adsorption of the gas or vapour shifts the balance slightly against the surface forces, so that

the block expands. Some experiments carried out in the laboratories of the British Coal Utilization Research Association have, in fact, shown that adsorption of vapour does cause some diminution of the area of contact between sub-microscopic particles. Thus, in experiments on the electrical conductivity of a rod of coke-like material, it was found that, when adsorption swelling took place, the resistance increased, indicating that the width of the inter-particle contacts had diminished. Different types of irreversible shrinkage, all well known in technical practice, were mentioned. The first, ageing, is most marked with a freshly aggregated mass of very fine particles or filaments. The slow prevailing of the surface over the elastic forces is probably due to molecular relaxations within the solid particles, which absorb the elastic energy and impart permanent set, with permanent adjustment of the particles to each other's shape at the area of contact. The shrinkage associated with drying may represent a continuation of this process, since the surface forces would be increased. The process of sintering is another illustration of the relative instability of the powdered state. Raising the temperature renders less effective the energy barriers which impart rigidity, and this appears to be the essence of the process.

Capillary condensation, in Dr. Bangham's view, appears to be subject to very serious limitations as an explanation of volume change of solids with changing content of liquid. The decrease of surface tension of a solid caused by saturation with the vapour of a liquid far exceeds the surface tension of the liquid itself. Thus, the surface energy of solids is of the order of thousands of ergs per sq. cm., the lowering of surface energy of solids by saturation of vapours is of the order of hundreds of ergs per sq. cm., while the surface energy of water, for example, is seventy-five ergs per sq. cm., and that of alcohols only twenty-two ergs per sq. cm.

Mr. H. H. Macey (British Refractories Research Association), in his paper on the "Cracking of Plastic Clay Articles during Drying", discussed many of the technical problems involved in manufacture. In the manufacture of any article from clay the ground raw material is mixed with sufficient water to render it capable of being moulded to the required shape, and, afterwards, it is dried to remove this water, and then fired. Problems of drying to avoid losses owing to shrinkage cracking are thus of much importance to the clay industry. A mixture of clay and water shows two distinct portions in the volume shrinkage/moisture content curve. During the first stage, the change in volume is equal to the volume of water lost, but below a certain moisture content shrinkage for all practical purposes ceases. The order of movement with which Mr. Macey was concerned here is, of course, large compared with the dimensional changes undergone by rigid solids with change in moisture content that were discussed in the previous papers. In effect, the second stage referred to by Mr. Macey, in which volume change is very small, is the parallel to the behaviour of a rigid solid. The moisture content at which the first-stage shrinkage ceases varies considerably with the type of clay, and although it generally lies within the range of 8–13 per cent of water, it may be as high as 20 per cent. Under constant conditions of temperature and humidity, the rate of evaporation while shrinkage is taking place is constant, and very close to that of the free water surface, and it is only when the shrinkage ceases that the water surface retreats below that of the clay and evaporation is governed by diffusion through the pores and the reduced vapour pressure. Mellor explained the shrinkage behaviour of a clay by the supposition of continuous water films between the surface of the clay particles. During drying, the shrinkage of these films results in a change of volume equal to the volume of water lost, and this holds until the particles come into contact and shrinkage ceases. The thickness of the water films in a plastic clay appear from recent work to be of the order of, but probably less than, 1,000 A.

The last formal paper of the symposium was by Mr. F. R. Himsworth (Imperial Chemical Industries, Ltd.), on the setting and expansion of plasters, and thus dealt with a rather different topic. The expansion of plaster of Paris on setting has been utilized for a long time to give sharp castings, and this valuable property has been the subject of many investigations; nevertheless, the results obtained are still inconclusive. Calcium sulphate exists in three states of hydration, anhydrite, gypsum, and the lower hydrate, generally known as hemihydrate or plaster of Paris; but the system is not so simple as it appeared. The hemihydrate seems not to be a definite hydrate but to behave like a zeolite, the limits of composition being $CaSO_4$ and $3CaSO_4.2H_2O$. The linear expansion of plaster of Paris on setting varies widely, being as high as 1 per cent in some cases and less than 0·1 per cent for the special low-expansion types. The actual volume change in the system in the reaction

$$CaSO_4.\tfrac{1}{2}H_2O + \tfrac{1}{2}H_2O = CaSO_4.2H_2O$$

involves a reduction of about 4 per cent. The expansion must, therefore, be explained in some way by the mode of crystal growth. Gypsum formed from the hydration of the plaster of Paris crystallizes in the monoclinic system, but its crystal habit varies greatly according to the solution from which it crystallizes. Accelerators of set in general tend to give small rod-like or needle crystals and, though they do not greatly increase the number of nuclei formed, they increase the rate of growth. Retarders have more marked effects, in general, reducing the number of nuclei formed and also the rate of growth. The effect on crystal shape is generally to decrease the elongation and increase the size. Immediately after plaster is mixed with water and placed in the mould, there is a contraction in volume which stops as soon as the plaster begins to set and which, with retarded plasters, has a maximum value of about 0·15 per cent by volume. It is followed by an expansion which is roughly parallel to the rate of hydration. This behaviour can, Mr. Himsworth suggested, be explained by assuming that before the plaster acquires rigidity the crystals are free to move without restraint, and the true reduction in volume corresponding to the hydration process occurs. As soon, however, as a rigid structure is formed, unidirectional growth takes place under conditions of restraint and causes the apparent expansion. It may be noted in this connexion that there are theoretical difficulties in the assumption that growth of a crystal in a not completely confined space from its saturated solution can exert a pressure, and more direct experimental proof of such a process is still required.

In a short contribution to the afternoon session, Prof. Bernal commented that the fibrillar material revealed by electron-microscope studies of set cement suggests an analogy with certain other fibrillar materials such as tobacco mosaic virus, and with the behaviour they show when the concentration of their

solutions is changed. Developing this in a concluding address, Prof. E. K. Rideal observed that the fibrils would presumably behave as supermolecules and that the ratio of crystalline to amorphous regions, which is of much importance with polymers, would probably have a large influence on the properties of set cement. In the dehydration of zeolites, water can be removed without altering the external appearance, but holes may be left in the structure which would admit molecules of hydrocarbons. More information is needed about energy changes in such processes. Some alumino-silicates have a disk-like structure, and up to four layers of water molecules can be adsorbed between each disk. The system remains ordered if water is removed slowly, but on quick drying a disordered state may result. For an ordered system, the expansion on wetting is lateral for a water-rich system, and perpendicular for a water-poor system. The transportation of silt within a cement mass may also be of importance. Prof. Rideal referred in addition to work on diffusion gradients at crystal edges and the existence of mobile layers at crystal boundaries. It is possible that re-arrangement in a cement–water system may take place by osmosis, by transportation of silt, or by molecular movements.

F. M. L.

ANTHROPOLOGY ON THE CONTINENT OF EUROPE IN WAR-TIME

AS has already been reported in *Nature* of May 18, p. 665, the Permanent Council of the International Congress of Anthropological and Ethnological Sciences visited England during April at the invitation of the Royal Anthropological Institute, and a most successful meeting was organised at Oxford by Sir John Myres, one of the joint secretaries of the Congress, to make arrangements for the next full meeting and to advance the work of the standing committees. The Royal Anthropological Institute took advantage of this gathering to invite the delegates to read short papers at informal meetings of the Institute in London, on the days immediately preceding and following the Oxford meetings, as a means of making better known in Britain and among the delegates themselves the progress made in anthropological science in their several countries since the outbreak of war brought international contacts to a stop. Eleven of the delegates accepted this invitation, and in addition two of the delegates delivered during their visits the Huxley Memorial Lectures for 1941 and 1945.

Mention should first be made of a full and illustrated account, given by Miss Johanna Felhoen Kraal (one of the Netherlands delegates) at an ordinary meeting on April 2, of the work of the Ethnographical Section of the Netherlands Institute for the Indies at Amsterdam, and particularly of the development of its policy in recent years under the late Prof. B. J. O. Schrieke, whose death in 1945 was so grievous a loss to Holland, to the East Indies and to anthropological science.

At the first of the special meetings, held on April 11, Prof. J. M. de Barandiarán, who attended as a delegate of France, gave an illuminating account of Basque studies during the past ten years, mainly under the auspices of the Basque Research Institute, founded in 1921, which publishes the *Anuario de Etnología* and the monthly *Eusko-Folklore*. The outbreak of the Spanish Civil War interrupted a number of important excavations at prehistoric sites in Spain which had already thrown much light on the origins of the Basque type so far back as the upper Palæolithic. Since 1937, the Institute's work had been confined to the French side of the frontier, and was on a reduced scale, though Prof. Barandiarán had himself made some important discoveries suggesting a correlation between the distribution of ancient dolmens and cromlechs and the nomadism still practised in the same areas. Ethnographical work included studies of current folk-lore which seemed to have prehistoric parallels.

Prof. Edouard de Jonghe (Brussels) gave a very full and authoritative account of war-time progress in anthropological knowledge of the Belgian Congo. Most of the Belgian universities, museums, learned societies and scientific publications carried on throughout the German occupation, generally on a reduced scale, and resisted German influence with success: there were practically no cases of 'collaboration' among anthropologists. Prof. de Jonghe himself was deported to Germany just before the arrival of the Allies in Belgium in 1944. The four years isolation of the metropolis from its colony naturally concentrated the energies of research workers in Belgium upon the working up of material already collected. In the Congo, on the other hand, the War saw a great expansion of anthropological research, especially in the applied field. Prof. de Jonghe's detailed account of work published during the War included, under the head of prehistory, works by Lobar and de Jonghe (in collaboration), Bertrand, Van der Kerken, Bequaert (on the prehistoric collections of the Tervueren Museum), Cabus, Van Moorsel and Mortelmans.

On the physical side, interesting and important work was done on the practical problems of health and demography; but in the special case of the pygmies much fundamental research was also carried out—by Father Schebesta, with his associates Jadin and Gusinde, on the Bambuti pygmies (including blood-group studies); by Jullien, on the blood-groups of the Efe pygmies; by Father Schumacher, in a monumental work to appear shortly, on the Lake Kivu pygmies; and by Twisselmans on the pygmies of West Africa, especially the French Congo. In the linguistic field, a vocabulary of Alur was compiled by Father Van Neste, and a grammar of Chiluba by Father Willems. The use of Chiluba as the national tongue of the whole Belgian Congo had long been advocated by Prof. de Jonghe, and an important session of the Institut Royal Colonial Belge was devoted to discussion of this problem in 1944. A preliminary essay in the application of linguistic geography to the Bantu languages was made by Father de Boeck.

Among general ethnological works was De Cleene's excellent "Introduction à l'Ethnographie du Congo" (written from a rather functional point of view), and important monographs were produced on the Mongo, Basongo and Bakongo by Van der Kerken, de Beaucorps and Mertens. News was also given of the Institute's great investigation of the forms of slavery in the Congo. Juridical ethnology made great strides in the Congo during the War under the influence of Sohier, as had the systematic study of Congo art in Belgium under that of Prof. F. M. Olbrechts. After a short reference to recent studies by Van Reeth, Smets and others in the religions of the Congo and Ruanda, Prof. de Jonghe concluded with an interest-

ing account of recent studies of African mentality and philosophy by De Cleene (following Levy-Brühl) and Father Tempels. This lecture was a remarkable testimony to the success with which Belgian science has surmounted its war-time difficulties.

Prof. Olbrechts followed with a masterly exposiiton of the scientific approach to the study of Congo art which he has done so much to develop in recent years, distinguishing in the space of an hour, with a large number of excellent illustrations, all the important regional styles, together with the characteristic features by which they may each be identified. The extraordinary variety of styles, nearly all represented by examples of great vigour and high artistic merit, must have convinced all his hearers that the Congo is as fruitful a field for the student of art as any place in the world, and his forthcoming book on the subject will be awaited with great interest. He distinguishes three main zones: the western, which includes the rather decadent and lifeless art of the Lower Congo tribes, so long subject to European contacts, as well as the more southerly Bajokwe, with their far more vigorous and elaborate forms, and the Bapende, whose initiation masks are so arrestingly evocative of death; the central zone, in which are found the Bushongo, whose 'Court style' produced the superb portrait statue of the early seventeenth century Great Chief Shamba Bolongongo—now on view at the British Museum—and the nearby Bena Lulua, with their utterly different but equally fine sculpture; and the eastern zone, where the Baluba are pre-eminent. Particularly interesting among the Baluba figures is a series of half a dozen or more sculptures, now scattered among the museums of Europe, which are so precisely alike in feeling and in many details of style that Prof. Olbrechts believes them to be all from the same master hand. The successful synthesis of the ethnological and æsthetic approaches developed in this lecture may be thought highly suggestive for many other regions of the world.

On their return from Oxford on April 16, the delegates were honoured at a reception and lunch by the president and fellows of the Royal Anthropological Institute, after which they visited the British Museum for a special preview of the ethnographical section of the exhibition due to be opened a few days later. After tea with the Folklore Society, they attended the delivery of the Huxley Memorial Lecture, postponed from 1941, by the Abbé Breuil on "La Découverte de l'Antiquité de l'Homme et quelquesunes de ses Evidences", at a special meeting of the Institute in University College. In his memorable address, the Abbé Breuil first surveyed the growth and present state of man's knowledge of his early past, as it had been revealed by geological and archæological evidence, and then gave an account of his war-time field researches, bearing on this subject, on the sea beaches of Morocco, Portugal and South Africa, which has produced some significant correlations. He suggested the possibility that the South African Old Stone Age cultures may actually have been the ancestors of the comparable cultures of Western Europe, Asia Minor and India.

On April 16, the Rev. Pater W. Schmidt gave a short account of some of the effects of war upon anthropological study in the countries with which he has been specially associated—Switzerland and Austria—and in particular gave news of the well-known periodical *Anthropos*, of which he was the editor; its publication was transferred before the War from Vienna to Fribourg in Switzerland, and for various reasons is likely to remain there for some time to come. In spite of much war damage in Austria, the Natural History Museum at Vienna remains intact. After referring to the Pontificio Museo Missionario-Etnologico Lateranense at the Vatican, of which he is head, he concluded with an appeal for toleration by belligerent governments of the missionaries on whom native peoples depend for guidance, except where individual missionaries are clearly guilty of subversive activity. The wholesale internment, on grounds of nationality, of German and Italian missionaries by the Allies and of European missionaries by the Japanese produced serious ill-effects. He was glad to welcome a more liberal policy in the recent British decision to re-admit the German missionaries in India, Australia and New Guinea.

Prof. Gerhard Lindblom reported that scientific research in Sweden had been relatively little affected by the War. He surveyed shortly the work and publications of Sweden's famous museums: the Ethnographical Museum of Sweden at Stockholm, under his own direction; the Ethnographical Museum at Gothenburg, where Izikowitz has succeeded Kaudern; the Museum of Far Eastern Antiquities at Stockholm, under Karlgren; the Northern Museum at Stockholm, with its very active Lapp Department under Ernst Manker; and the State Historical Museum at Stockholm, rehoused in 1943, until lately under Arne's direction. On the teaching side, while interest in physical anthropology as such is still in its early stages, the study of general ethnology (now including more social anthropology) and of archæology is very well established in Sweden and has received further notable recognition during the past seven years; and Nordic ethnology is in a particularly flourishing condition, with important researches proceeding under Erixon, Svensson, Campbell and others. The most significant impression to be gained by a British audience from this admirable account was that of the very close and obviously successful interconnexion of the work of the museums and the universities in Sweden, with Lindblom, Karlgren, Izikowitz, Svensson, Lagercrantz and others dividing their energies between the two and helping to foster that integration of ethnological studies which has provided a firm basis for the expansion of activity and of public interest in those studies.

The first of three papers given on the evening of April 17 was by Prof. H. V. Vallois, who reported on the condition of physical anthropology in France during the war years under the three heads of the modern population of France, the coloured races of the French Empire, and fossil man. Systematic field-work in Brittany, the central massif, the Pays Basque and the north of France included an investigation of blood-group distribution which brought to light important regional differences, correlated with morphological characters. Other researches dealt with the Armenians and the Negroes resident in France, and a good deal of material gathered in Africa before the War was worked up and published. Studies of prehistoric remains included those of the Mesolithic men of Deventer (Pays-Bas) and le Cuzoul de Gramat (Département du Lot) and of the Neanderthal man of Rabat in Morocco. Prof. Vallois mentioned that the progress made in ethnology and prehistory was equally impressive, in spite of the very difficult working conditions for French science and the unwelcome attentions of the German police.

The address by Prof. G. H. Rivière, keeper of the Musée National des Arts et Traditions Populaires in Paris, on war-time research in the ethnography of France, should be well pondered, not without mortification, in Great Britain, where, but for the pioneer work of Dr. Peate in Wales, we have little indeed to set beside French achievements of recent years. A determined effort is being made by the French museums service, now under the control of the Ministry of Education, to record systematically the fast disappearing 'popular arts' of the country: the principal investigations undertaken during the War covered domestic furniture, rural architecture (for the purposes of reconstruction) and artisan techniques (including pottery, metallurgy, weaving, woodworking and basketry). Specimen files shown by Prof. Rivière for each of these researches gave a striking impression of the thoroughness, completeness and systematic efficiency without which such nation-wide investigations could scarcely be successfully undertaken. Lesser researches related to marionette theatres, folk-songs of Brittany, folk-tales, and to preparations for an ethnographical atlas of France and ethnographical monographs on particular French communities studied from all aspects. In 1945, the 557 provincial museums concerned with French ethnography were reorganised under a master plan providing for the division of their collections into carefully selected and well-spaced temporary exhibitions and larger reserve collections for scientific study. It may be hoped that full accounts of these developments will soon be available in Britain, for, without necessarily accepting so high a degree of centralization, we may gain much inspiration from French experience.

Prof. Sergio Sergi, of Rome, gave a short report, illustrated with photographs and diagrams, on the very important discoveries of human remains of Palæolithic age which he made at Saccopastore and Monte Circeio during the War, together with comparisons of the crania with those of other known specimens of Palæolithic man.

In physical anthropology, as in domestic ethnography, Great Britain lags at present far behind, and Prof. Tamagnini's talk on April 18, outlining remarkable progress made in Portugal, was fresh and salutary proof of this. After a short sketch of the history of anthropological studies in Portugal (with their emphasis from the beginning on the physical side), he summarized current research activities at Lisbon (under Heleno, de Vilhena and Barbosa Sueiro), Porto (Mendes Corrêa and Pires de Lima) and Coimbra (the speaker himself and Serra). Finally, he described his own Institute's very large and important statistical undertaking, in which the genealogical method is being applied to the study of blood groups and other characters among great numbers of families in the Department of Coimbra.

Prof. Valšik of Prague gave a very brief statement of the effect of German occupation upon Czechoslovak anthropology. All organised research in science had stopped, in default of any subservience to the Germans, and no publication had been possible. Physical anthropologists, such as himself, had mostly been engaged on the applications of science to health.

Lastly, Prof. Shevket Aziz Kansu's short but informative review of recent progress in Turkey showed that he and his colleagues were extremely active during the War, and that all branches of the science were being very successfully developed there.

On April 30, Prof. A. L. Kroeber, the United States delegate, delivered the Huxley Memorial Lecture for 1945 on "The Ancient Oikoumenê as an Historic Culture Aggregate", a memorable development of some aspects of his interpretation of cultural diffusion through the Eurasian land mass from the earliest times to the present. W. B. Fagg

OBITUARIES

Prof. G. N. Lewis, For.Mem.R.S.

By the death of Gilbert Newton Lewis in his seventy-first year the world has lost one of the greatest of its physical chemists. Since 1898, when he published his first paper with T. W. Richards on "Some Electrochemical and Thermochemical Relations of Zinc and Cadmium", until his last paper on "Paramagnetism of the Phosphorescent State" in 1945, he wrote some hundred and sixty-five papers on many branches of physical chemistry.

There are few branches of our science which 'G. N.' did not illumine by contributing something new and something fundamental to them. He was appreciated most widely abroad, not only for his concept of the static atom and the clear views on valency, notably the electron pair which that gave rise to, but also for his contributions to the thermodynamics and free energies of chemical substances and solutions, which introduced conceptions such as thermodynamic activity and fugacity now universally adopted. Many of the free-energy relationships were determined by means of electrode potentials—a field to which he devoted much attention. Lewis was the first (1933) to isolate deuterium, the heavy hydrogen isotope, to show its possibilities in the study of isotopic reactions, and to determine the physical properties of liquid and solid deuterium. His papers on acids and bases, on ultimate rational units and dimensional theory, give some indication of the wide interests of a gifted mind. During the last five years of his life he became deeply concerned with the problem of fluorescence, contributing some fifteen papers on this subject. His last papers, on phosphorescence and paramagnetism, were published last year.

The small volume printed in Berkeley to commemorate his seventieth birthday reveals how much America in its universities and industries is indebted to the school of which G. N. Lewis was the active and stimulating head. Among his many honours he received the Davy Medal of the Royal Society and was an honorary fellow of the Royal Institution. Some of us at Cambridge remember the summer when he paid us a visit, memorable for the enthusiasm which he imparted to all, and to the endless source of wonder and interest to his children which the differences in the countryside of California and Cambridge provided. Eric K. Rideal

Prof. F. Broili

Ferdinand Broili, professor of palæontology and historical geology in the University of Munich, died on April 30, aged seventy-two. He was a student of v. Zittel and Rothpletz in Munich, visited the Permian of Texas in 1898 and there collected materials on which, during the next ten years, he published a series of important papers on reptiles and amphibia. He then wrote on the Permian Brachiopods of Timor

and on a variety of fossil reptiles. After the War of 1914–18, he became professor of palæontology and historical geology in Munich and director of the Bavarian State Palæontological Museum; in this capacity he added very greatly to the collections, which became the most important in Continental Europe. Broili then worked on Pterodactyls and other reptiles from the Sohenhofen Slate, until, as his collection increased, he published many papers on the fauna of the Devonian Slates of Gemünden. Later, in association with Schroeder, he wrote a long series of admirable papers on the vertebrates of the Karroo system of South Africa.

Broili thus produced a very great amount of most valuable work on invertebrates as well as on all the lower classes of vertebrates. All of it is clearly written, well illustrated, and contains important discussions of relationships and other general matters. In addition he produced new editions of the famous text-book, Zittel's "Gründzuge der Paläontologie", which are still of great practical use.

Broili was most generous in his reviews of the work of younger men, and in lending to other workers the materials of which he had charge; and he enjoyed the respect and friendship of palæontologists throughout the world. D. M. S. WATSON

Mr. J. A. Gardner

IT was in the spring of 1911 that the Biochemical Society was founded by John Addyman Gardner, in association with other biochemists of that time. The recent announcement of his death will have been received with regret, but with feelings of admiration for a life so well spent.

An energetic native of Bradford, Gardner had a distinguished career at Oxford, obtaining first-class honours in the School of Natural Science in company with quite an array of distinguished Oxford chemists of his day. From Oxford he was appointed chemist to St. George's Hospital, London, a position he held until quite recently. He was for some time reader in physiological chemistry in the University of London and lecturer in organic chemistry at the London School of Medicine for Women. Always a keen research worker, his activities were for the most part conducted as biochemist at the Waller Physiological Laboratory. In this laboratory, which was at that time in the Imperial Institute at South Kensington, Gardner gathered round him a number of enthusiastic co-workers in the then rapidly spreading field of biochemistry.

Gardner was not alone in his desire to further the study of this subject, nor was he the only chemist to recognize the danger in those days of not keeping abreast of the knowledge of the medical aspects of chemical science. Prof. R. H. A. Plimmer, at that time reader in physiological chemistry at University College, was closely associated with Gardner in those activities, and jointly they called together a meeting which led to the foundation of the present Biochemical Society, which now has a membership roll of more than a thousand. Another pioneer was the late Prof. B. Moore, of the University of Liverpool, who with great foresight handed over to the new society the *Biochemical Journal*, which he was at the time publishing. The late Sir Arthur Harden and the late Prof. W. M. Bayliss gave their willing services as editors of the *Journal*.

Gardner was treasurer to the Society for more than twenty-two years. With great skill he nursed it through the difficult days of the First World War. He lived to see the Society with a world-wide membership including many eminent men of science, and a journal containing many important contributions to medical chemistry, and much of the development of our present-day knowledge of such substances as the vitamins and the sterols. It was to the last-mentioned field of study that much of Gardner's own work was directed.

The researches in which Gardner was concerned covered a wide field. He will be remembered with deep gratitude and affection by a number of co-workers for his kindly help and encouragement in their work. His researches on "The Origin and Destiny of Cholesterol in the Animal Organism", carried out in collaboration with a number of post-graduate workers, are among his best known. He clearly showed that cholesterol was widely distributed in living tissues, that it was strictly conserved and in the growing animal was not synthesized, but probably entirely derived from the phytosterol content of foods. This constant but small occurrence is perhaps explained as a source of the many essential sterols which since Gardner's earlier work have been brought to light; for we now recognize as chemically related to cholesterol a great variety of significant biochemical substances such as the cholic acids, the D vitamins, the sex and other hormones. With the late Prof. G. Buckmaster, Gardner published a number of observations on chloroform anæsthesia. The earliest work was on the chemical constitution of some of the terpenes carried out in conjunction with the late Dr. J. E. Marsh. Gardner's more recent work was on a variety of subjects of biochemical interest.

Gardner's contribution to science, whether it be his extensive research work, his help and encouragement to so many of his co-workers in biochemistry, or whether it be his share in the establishment of an important scientific society, constitutes a magnitude of endeavour which is given to few to accomplish.

G. W. ELLIS

Dr. H. E. Wood

HARRY EDWIN WOOD was born in Manchester on February 3, 1881, and died on February 27, 1946, at Mortimer, Cape Province, a few days after a heart attack. He studied physics at Manchester, Sir Arthur Eddington being one of his fellow students, and became an assistant to Sir Arthur Schuster. Before going to South Africa in 1906 to take up his duties as chief assistant at the former Transvaal Meteorological Observatory (now the Union Observatory) under R. T. A. Innes, he prepared himself by a period of work at the British Meteorological Office.

Soon after Wood's arrival, the Transvaal Observatory entered the astronomical field, Innes working with the 9-in. visual refractor, Wood concentrating mostly on the famous Franklin Adams star camera. This remained his principal instrument until the day of his retirement in 1941. Meanwhile he had succeeded Innes as Union Astronomer on January 1, 1928.

Wood was a diligent and careful observer, who used the instrument in his charge for those types of astronomical observation for which it was eminently suitable by virtue of its short focal-length, large field

of good definition and powerful light-grasp: discovery and measurement of minor planets, comets, variable stars and the preparation of star charts for the southern sky. For many years the responsibility for observing the minor planets which came to opposition in southern declinations rested almost entirely on his shoulders. He discovered several of these elusive objects and computed the first orbits for many of them, as he did in the case of comets. A few days before his retirement he computed the first orbit for the bright comet discovered by Mr. de Kock, using three of his own observations obtained with the Franklin Adams camera on three successive nights. Notwithstanding this short time interval, his orbit proved to be a remarkably close approximation, thus demonstrating his powers as a careful observer and computer.

Though mainly a photographic observer, Wood also took a regular share in visual observing of occultations of stars by the moon, phenomena of Jupiter's satellites, micrometer observations of comets, etc. He was also in charge of the Wiechert seismograph at the Union Observatory over a period of many years, and made a careful study of the earth tremors caused by mining operations on the Witwatersrand.

Wood was a gifted, clear and interesting lecturer; for some time he gave the lectures on astronomy at the University of the Witwatersrand, which in 1937 conferred the honorary degree of doctor of science on him. After his retirement he prepared a series of radio talks on astronomy for the schools.

During the War of 1914–18 he served with the Union Defence Force and took part in the campaign in East Africa. There he contracted malaria, with serious results to his health in later life. Wood married a former Manchester fellow student. His widow survives him; they had no children.

W. H. VAN DEN BOS

WE regret to announce the following deaths:

Prof. B. H. Bentley, emeritus professor of botany in the University of Sheffield, on June 24, aged seventy-three.

Sir George Julius, chairman of the Commonwealth Council for Scientific and Industrial Research, Australia, aged seventy-three.

NEWS and VIEWS

Canadian Honours List

THE following names of scientific workers and others associated with scientific affairs appear in the honours list issued on the occasion of Dominion Day, July 1, in Canada:

C.M.G.: Dr. Alexander T. Cameron, chairman of the Fisheries Research Board, Winnipeg; Dr. D. B. Finn, deputy minister of fisheries, Ottawa.

C.B.E.: Dr. E. S. Archibald, director of the Experimental Farm Service, Department of Agriculture, Ottawa; Prof. C. W. Argue, professor of biology, University of New Brunswick; Prof. H. C. Bazett, of the Banting and Best Institute, Toronto; Dr. J. G. Bouchard, assistant deputy minister, Department of Agriculture, Ottawa; Dr. R. D. Defries, director of the Connaught Laboratories, Toronto; Mr. A. Hunter, chairman of the Standing Committee on Nutrition, Department of National Defence, Toronto; Dr. Otto Maass, of the National Research Council, Ottawa; Mr. J. H. Parkin, of the National Research Council, Ottawa; Dr. J. M. Swaine, formerly director of Science Service, Department of Agriculture, for services as a member of the Agricultural Supplies Board, Ottawa; Mr. W. B. Timm, director of the Mines and Geology Branch, Department of Mines and Resources, Ottawa; Mr. J. M. Wardle, director of the Surveys and Engineering Branch, Department of Mines and Resources, Rockcliffe, Ontario.

Royal Society of Edinburgh

THE following have been elected honorary fellows of the Royal Society of Edinburgh:

Foreign honorary members: Prof. H. G. Backlund, emeritus professor of geology, University of Uppsala; Prof. J. Hadamard, formerly professor of mathematics, Collège de France, and l'École Polytechnique, Paris; Prof. J. H. Hildebrand, professor of chemistry, University of California, Berkeley; Prof. S. A. S. Krogh, professor of animal physiology, Zoophysiological Laboratory, Copenhagen; Prof. E. O. Lawrence, professor of physics, University of California, Berkeley; Prof. E. D. Merrill, professor of botany, Harvard University; Prof. J. H. F. Umbgrove, professor of geology, Technische Hoogeschool, Delft.

British honorary members: Prof. E. D. Adrian, professor of physiology, University of Cambridge; Prof. F. T. Brooks, professor of botany, University of Cambridge; Sir James Chadwick, professor of physics, University of Liverpool; Prof. P. A. M. Dirac, Lucasian professor of mathematics, University of Cambridge; Prof. G. H. Hardy, emeritus professor of pure mathematics, University of Cambridge; Sir George Simpson, formerly director of the Meteorological Office, London.

The Keith Prize (1943–45) was presented at the meeting on July 1 to Dr. W. L. Edge, University of Edinburgh, for his work in geometry, particularly for his papers published in the *Proceedings* of the Society within the period of the award; and the Neill Prize (1943–45) jointly to J. G. Carr, Institute of Animal Genetics, University of Edinburgh, for his contributions to our knowledge of tumour viruses in animals; and to Dr. Ethel D. Currie for her paper on "Growth Stages in some Jurassic Ammonites", published in the *Transactions* of the Society within the period.

Romano-British Silver Hoard in Suffolk

A REMARKABLE find of Roman silver plate of a highly elaborate character at Mildenhall, Suffolk, has recently been reported in the Press. The discovery was made by Mr. Sidney Ford, of West Row, Mildenhall, who, while ploughing recently, turned up a circular silver dish which is more than two and a half feet in diameter and weighs some 224 ounces. Further exploration of the ground with a spade brought to light thirty-three more pieces of plate, all of silver and most of them elaborately embossed and ornamented. These include a second large circular dish,

slightly smaller than the first, two smaller dishes, embossed with figures, several ornamented bowls, a pair of standing cups, a large fluted bowl with a pentacle as ornament at its centre, a number of detached handles, spoons, small cups and ladles, and a convex ornamented cover with the figure of a child as handle. The large circular dish is a remarkable piece on aesthetic grounds, apart from its size and weight. It is a characteristic example of Romano-British style of the later period of the Roman occupation, crowded with exuberant figures executed with great technical skill (see *Illus. London News*, June 29). There are many points of interest connected with this find which no doubt will give rise to much discussion in the future. It is possible to mention here only one—that of the dating. It has been suggested that the hoard may have been buried about the end of the third century of our era, that is, about A.D. 300, but a later date by some fifty years seems possible. Apparently this find belongs to that class which consists of household goods of villas buried when in danger from raiders. But according to the evidence of coins from such hoards, this practice did not begin until near the middle of the century and came to an end when in A.D. 367 Romano-British villa life in East Anglia suffered its final blow at the hands of barbarian sea-raiders.

Rayon Technology at Manchester

In accordance with their declared policy of providing financial assistance for the development of technical education in subjects of importance to the British rayon industry, Messrs. Courtaulds, Ltd., last week announced a gift of £60,000 to the Manchester College of Technology, which is also the Faculty of Technology in the University of Manchester. The money will for the most part be used for completely re-equipping the two Departments of Textile Industries and Textile Chemistry with up-to-date machinery and apparatus for training and research in rayon technology. The gift is particularly opportune because building is about to be resumed on the considerable extensions to the College which were started before the War and in which space had already been earmarked for rayon development, especially in reference to research. These plans can now be brought to fruition much more completely and more quickly than would otherwise have been possible.

The past decade has witnessed a notable increase in the number and variety of man-made fibres available to the textile industries. Of equally great importance, however, are the great strides that have been made in the study of their behaviour and properties, and in the growing appreciation of their independent significance in the textile economy as a whole. This has led, on one hand to the opening up of new fields of application, and on the other to a complete re-consideration of the orthodox sequence of industrial operations by which these materials in their different forms are commonly spun, woven, dyed and finished. The fundamental principles of fibre treatment are for the most part applicable to all textile materials, whatever their origin; but in the application of these principles, so far as the rayons are concerned, there are now in prospect more radical departures from orthodox practice than have been made hitherto. As a result of Messrs. Courtauld's gift, the Manchester College of Technology will be able not only to demonstrate the latest types of machinery and process but also play a much larger part, by experiment and research, in contributing to their further development.

Education in the Royal Air Force

The Air Council has now approved the formation of an Education Branch of the Royal Air Force in place of the civilian Educational Service that has existed hitherto. Education officers will now become part of the Royal Air Force itself, instead of being members of a civilian auxiliary service. The R.A.F. Education Branch, which will consist of commissioned officers only, will be constituted on the same broad lines as other branches of the Royal Air Force. The Branch will be organised on a predominantly short-service basis, provision being made for a percentage of short-service officers to be granted permanent commissions. Vacancies in the permanent cadre will normally be filled from the ranks of short-service officers, but officers with qualifications of outstanding value to the R.A.F. may exceptionally be appointed direct to permanent commissions. The intention is that officers should be appointed to short-service commissions, for a period of five years on the active list followed by four years on the reserve, and that they will enter at an average age of twenty-five in the rank of flying officer, normally after having had some civil teaching experience.

Service in the Education Branch of the Royal Air Force will be recognized by the Ministry of Education for determining the correct incremental position on the Burnham scales of salary of teachers who afterwards enter or return to civilian teaching employment. Further, the period of the short-service engagement of officers of the Education Branch who have been in contributory service under the Teachers (Superannuation) Acts will reckon as contributory service towards any ultimate award of pension under those Acts. It is hoped that it will be possible to make similar provision for short-service officers who were not in contributory service before entering the Branch. Candidates for appointment to the Branch must be in possession of a full degree of a university or an equivalent qualification obtained by examination, and the possession of first- or second-class honours will normally be a requirement for appointment to a permanent commission. A detailed announcement will be made as soon as possible with regard to the conditions of entry to and service in the new Branch, together with information regarding the conditions of assimilation of existing members of the R.A.F. Educational Service.

International Academy of the History of Science

The activities of the International Academy of the History of Science were suspended during the War. Prof. Aldo Mieli, the permanent secretary, is not at present able to leave Buenos Aires, and it has not yet been possible to resume publication of *Archeion*, the journal of the Academy. It has been decided, however, to hold a congress at Lausanne in the summer of 1947. All interested in the subject will be welcome, and the following provisional measures have been taken: J. A. Vollgraff (Roodbortsstraat 17, Leyden, Holland) is acting as secretary-treasurer, and Prof. P. Brunet (Hotel Nêvers, 12 Rue Colbert, Paris 21ème) as archivist and librarian. Prof. Arnold Reymond, of Lausanne, was elected president at the last meeting and will preside at the next. A corrected list of the surviving members of the Academy is being compiled. Each individual member and each national group is urgently requested to send the necessary information either to Prof. Brunet or to M. Vollgraff. Suggestions for the replacement of

both executive and corresponding members who have died since 1938 will be welcomed. Prof. Brunet further wishes to receive from members copies of books and brochures published by them since 1939, together with a note both of their own activities and that of their national group during the intervening period. Obituary notices of those who have died, together with photographs, are also desired.

Mineral Resources and Exploration

In his presidential address delivered on May 16 before the Institution of Mining and Metallurgy, Mr. G. F. Laycock reviewed the general position as regards the probable world resources of some of the more important metals, the prospects of finding further supplies and the methods employed in the search for new ore-bodies. For many years past few discoveries of important deposits have been made, apart from gold and iron. In Canada, for example, 84 per cent of the 1942 production was obtained from mineral areas discovered before 1920, and only 5 per cent from those discovered since 1930. Except in the U.S.S.R., the position is probably much worse in most other countries. Obviously, to a very large extent we are to-day living on our mineral capital. While it is clear that the era of surface prospecting has entered the phase of diminishing returns, there is every probability that many valuable ore-deposits, which do not outcrop or even closely approach the surface, still remain to be discovered. Mr. Laycock emphasizes the following suggestions: (1) Intensive research should be directed towards the development of new or improved methods of geophysical exploration with a view to the elimination of the uncertainties and weaknesses of existing methods. (2) Operating companies must be officially encouraged, for example, by tax reliefs, to carry out intensive prospecting for new sources of ore in and around existing workings by means of geological, geophysical and diamond-drilling methods. (3) Exploration companies should be formed to investigate potentially promising virgin areas where old-fashioned prospecting methods are useless by themselves; prospecting rights must be granted over wide areas, and the very considerable expenses of such large-scale operations should be allowable for taxation purposes as deductions against any future profits. Mr. Laycock predicts that with such stimulation and governmental assistance the present unsatisfactory position is likely to be greatly improved by the discovery of important concealed deposits.

Chemical Engineering as a Profession

There is a very marked expansion at the present moment of those industries which are mainly concerned with some chemical process for their development. There is so great a demand for chemical engineers that the Institution of Chemical Engineers, in conjunction with the Institute of Petroleum, the Association of British Chemical Manufacturers and the British Chemical Plant Manufacturers Association, addressed a memorandum to the Government, directing attention to this remarkable development, and at the same time emphasized the very great shortage of trained chemical engineers in Great Britain compared, for example, with that existing in the United States. The number of students each year studying for a degree in chemical engineering is at present about forty in Britain, compared with three thousand in the United States. To meet the situation, the Government is proposing to establish courses in chemical engineering for those who already have a chemistry, physics or engineering degree, as a short-term policy in order to train chemical engineers to meet this demand, which at the present moment is more active on the plant-manufacturing side, owing to the fact that many proposed improvements and developments have had to be postponed until after the War. While, therefore, at the moment there is a special demand for men to design and erect this equipment, there are also big requirements for chemical engineers in the industries using plant. The fourth year of the degree course recommended by the Institution of Chemical Engineers roughly corresponds to the post-graduate courses now being organised. The exact training which the students receive will depend, of course, to some extent on their previous knowledge, and will be designed to enable them to approach the chemical engineering course proper with sufficient background in the general principles of chemistry and mechanical and electrical engineering.

Recent Earthquakes

During May 1946 several strong earthquakes occurred in various parts of the earth. Many of these had their epicentres under the sea and thus fortunately did little material damage. These include the shocks of May 3, south-east of New Guinea; May 8, west of Sumatra; May 9, Gulf of California; and May 15, off coast of Southern Mexico (United States Coast and Geodetic Survey). The shock of May 21 did damage on Martinique, West Indies. Its epicentre has been determined on the basis of instrumental reports from eleven observatories by the United States Coast and Geodetic Survey as being lat. 14·2° N., long. 60·8° W., and origin time 09 h. 16·6 m. G.M.T. Two strong shocks at 02·30 hr. and 04·40 hr. on May 30 with epicentre in Canton Valais, Switzerland, did some damage to a church and houses at Bex. Houses were badly shaken at Berne, but no damage was done. In addition to the shocks of May 3 and 8, Mr. E. W. Pollard in the Isle of Wight recorded a smaller distant shock on May 11.

Early on Saturday, June 1, a severe earthquake occurred in the region of Mush, eastern Anatolia, Turkey, about 480 miles south-east of Ankara. Severe damage is reported to include 215 houses destroyed; 590 people are said to have been killed and about 100 injured.

Films in Microbiology and Protistology

Films made under the direction of Dr. Comandon by the Département de Cinémicrographie, Institut Pasteur, Garches, S. et O., will be brought to Great Britain shortly by M. Pierre de Fonbrune. They include those reviewed in the *Lancet* (Jan. 11, 1946, p. 111) and in the *British Medical Bulletin* (4, No. 1, 72; 1946); also films on *Amœba verrucosa* and *Lankesterella* and on mitosis. They are silent films on 35 mm. stock with captions in French. A selection of these films will be shown in London by the British Council on July 15, at 5 p.m. A limited number of seats is available and will be allotted in rotation on application to the British Council, 3 Hanover Street, London, W.1.

Study Group on Special Librarianship

THE Association of Special Libraries and Information Bureaux is proposing to repeat the successful experiment of last year of organising a study group on special librarianship in collaboration with the Library Association. This will be held at Chaucer House, London, during August 12–17. There will be lectures in the mornings, and in the evenings talks and discussions on special topics, while in the afternoons it is hoped to arrange visits to a number of special libraries. Full details and application forms can be obtained from the Director, ASLIB, 52 Bloomsbury Street, W.C.1.

University of London

DR. A. D. Ross has been appointed to the University chair of civil engineering tenable at King's College from October 1; since 1935 he has been lecturer in the Department of Civil and Mechanical Engineering at the College.

Mr. S. H. Beaver, lecturer in geography at the London School of Economic and Political Science, has been appointed to the Sir Ernest Cassel readership in economic geography tenable at the School.

The degree of D.Sc. of the University has been conferred on: Mr. J. F. Kirkaldy (King's College); Mr. S. Maulik (Imperial College of Science and Technology); Mr. B. S. Rao (University College); Mr. T. Small (King's College); Mr. A. R. Collar (external student).

Institution of Electrical Engineers: Awards

THE Council of the Institution of Electrical Engineers has made the following awards of premiums for papers read, or accepted for publication, during the session 1945–46: *Institution Premium*, Dr. F. C. Williams. *John Hopkinson Premium*, J. F. Coales, J. C. Calpine, and D. S. Watson. *Non-Section Premiums*, R. H. Coates and B. C. Pyle (Ayrton Premium); J. C. Read (Llewellyn B. Atkinson Premium); F. Ashworth, W. Needham, and Dr. R. W. Sillars (Extra Premium). *Installations Section Premiums*, R. Grierson and Forbes Jackson (Crompton Premium); Dr. A. J. King (Swan Premium); J. C. Macfarlane, Dr. J. W. Macfarlane, and W. I. Macfarlane (Extra Premium). *Measurements Section Premiums*, Dr. A. L. Whiteley (Silvanus Thompson Premium); C. G. Garton (Mather Premium); Dr. A. Fairweather (Extra Premium). *Radio Section Premiums*, Dr. H. G. Booker (Duddell Premium); E. C. Cherry (Ambrose Fleming Premium); C. F. Booth and F. J. M. Laver (Extra Premium); R. J. Clayton, Dr. J. E. Houldin, Dr. H. R. L. Lamont, and W. E. Willshaw (Extra Premium); Dr. R. A. Smith (Extra Premium); E. C. S. Megaw (Extra Premium); O. L. Ratsey (Extra Premium); R. J. Dippy (Extra Premium); Dr. N. R. Campbell and V. J. Francis (Extra Premium). *Transmission Section Premiums*, Dr. L. G. Brazier (Sebastian de Ferranti Premium); A. G. Ellis (John Snell Premium); P. J. Ryle (Extra Premium). *Fahie Premium*, F. C. McLean and F. D. Bolt. *Paris Exhibition* (1881) *Premium*, J. S. Pickles and W. H. Wills. *Webber Premium*, Dr. D. H. Parnum. *Willans Premium* (awarded triennially by the Institution of Electrical Engineers and the Institution of Mechanical Engineers), R. W. Biles and G. W. Maxfield, for their paper on "Standards of Performance of Generating Plant based on Five Years Operating Data".

Announcements

DR. JOHN A. FLEMING, director since 1935 of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, has retired, but will remain at the Institution temporarily as adviser in governmental and international scientific relations. It will be recalled that Dr. Fleming was awarded the Charles Chree Medal for 1945 of the Physical Society of London (see *Nature*, December 1, 1945, p. 658). Dr. Fleming will be succeeded by Dr. M. A. Tuve, chief physicist of the Department.

THE Institution of Chemical Engineers is establishing two bursaries, each of £100 a year, to assist students to obtain a bachelor's degree in chemical engineering. Candidates must have reached the higher school certificate or intermediate B.Sc. or equivalent standard; they may have spent a period in industry or in H.M. Forces. The bursaries will be tenable for three years. Applicants should be British subjects by birth. Applications should be addressed to the Joint Honorary Secretaries, Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1, by whom they must be received not later than August 1.

THE Trustees of the Busk studentship in aeronautics, founded in memory of Edward Teshmaker Busk, who lost his life in 1914 while flying an experimental aeroplane, have awarded the studentship for the year 1946–47 to Richard Peter Boswell, of Hawker Aircraft, Ltd.

THE four Exhibition Galleries of the Imperial Institute, London, have been re-opened to the general public from 10 a.m. until 4.30 p.m. on weekdays. There is a display of Empire films in the cinema of the Institute each day at 3.30 p.m.

THE Present Question Conference (Secretariat, 37 Middleway, London, N.W.11) will meet at University College, Exeter, during August 20–27. The purpose of this Conference is to consider in a practical way various approaches to the question: "Is the present chaos caused by lack of scientific planning, or by failure to recognize the reality of Spirit? The answer may be found through a deeper understanding of the nature of man." It is believed that an experimental approach will prove of value in obtaining a synthesis between the opposing points of view of science and religion. The announcement is signed by, among others, Dr. W. R. Matthews, Dr. Stephen Neill and Prof. A. D. Ritchie.

A USEFUL 64-page pamphlet by G. A. Campbell and T. F. West entitled "The Truth about D.D.T." has recently been issued by Findon Publications, Ltd. (1*s*.). The original discovery of this compound is traced from when it was achieved in Basle, many years ago, up to its most recent applications, whether incorporated in dusts, spray fluids or mixed with paints, distemper, etc. For those wishing to know the essential facts concerning this insecticide and its potentialities, this simply written account will give the desired information.

IN the graph accompanying the communication entitled "Dielectric Behaviour of 'Polythene' at Very High Frequency" by J. G. Powles and W. G. Oakes in *Nature* of June 22, p. 840, the wave-length scale has inadvertently been shifted to the left; the right-hand end of the scale (1 cm.) should be vertically below $3{\cdot}33 \times 10^{10}$ on the frequency scale.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

New Synthetic Contact Insecticides

SOME laboratory experiments have been made to estimate the relative toxicity to body lice and to bed bugs of several new synthetic insecticides which have been produced on an industrial scale during recent years in Britain, Germany and the United States. They comprise the following types: (1) D.D.T.; (2) certain analogues of D.D.T.; (3) 'Gammexane'; (4) chlorphenyl chlormethyl sulphone.

The various substances were tested as sprays in mineral oil solution and also (rather less accurately) as dry powders diluted with kaolin. Fuller details of the methods will be published in due course. In the accompanying table, the samples are compared by their median lethal concentrations for the two insects, under the conditions of the experiments. These results call for certain comments.

		Median lethal concentrations (%)			
		Oil spray		Dust	
		Lice	Bugs	Lice	Bugs
1.	D.D.T.	0·3	0·53	0·4	0·5
2*a*.	'Lauseto' mixture	1·2	—	—	—
2*b*.	Diffuor diphenyl trichlorethane	1·4	5·0	1·2	3·0
2*c*.	Dichlor diphenyl dichlorethane	0·9	1·2	2·4	1·0
3.	'Gammexane'	0·016	0·051	0·005	0·015
4.	Chlorphenyl chlormethyl sulphone	0·1	0·2	0·2	0·6

(1) D.D.T. There is already a considerable amount of information about this insecticide, so that it may serve as a standard for comparison. The material used was pure *pp*-D.D.T. (m.p. 108° C.) obtained from the Chemical Defence Experimental Station, Porton.

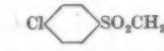
(2) D.D.T. Analogues. (*a*) 'Lauseto'. In Germany, an insecticide of this name was used during the War to impregnate clothing against body lice, using an emulsion method. A sample of the active principle was tested. This is prepared[1] by the reaction of benzene with chlorbenzene and chloral, so that, as well as D.D.T., it probably contains 2,2-*bis*-(phenyl)1,1,1-trichlorethane and 2-phenyl, 2-chlorphenyl, 1,1,1-trichlorethane. It was claimed that this mixture, which is a viscous brown liquid containing excess reactants, is easier to emulsify than D.D.T. As can be seen, it is only about a quarter as toxic as pure D.D.T. to lice.

(*b*) 'Gix'. This is another German insecticide, the active constituent being 2,2-*bis*(*p*-fluorphenyl)1,1,1-trichlorethane (m.p. 45° C.), a sample of which was supplied by the Geigy Co., Ltd. It was claimed by workers at the I. G. Plant Protection Laboratory at Hochst that this compound is more effective than D.D.T. to a number of pests, including gypsy moth, brown tail moth, grain weevil, roaches, red scale and houseflies. According to Kilgore[2], however, their test methods are somewhat suspect. This 'fluorine-D.D.T.' is certainly much less toxic than D.D.T. to lice and bed bugs.

(*c*) 'D.D.D.' or 'T.D.E.'. The compound 2,2-*bis*(*p*-chlorphenyl)1,1-dichlorethane (m.p. 111° C.) has been shown to be about as toxic as D.D.T. to mosquito larvæ in laboratory tests[2]. It has been produced commercially in the United States with the claim that it is of the order of toxicity of D.D.T. to insects and decidedly less toxic to mammals. Towards lice and bed bugs it appears to be about a third as insecticidal as D.D.T.

(3) 'Gammexane'. Some pure gamma hexachlorocyclohexane (m.p. 112° C.) was obtained from Imperial Chemical Industries, Ltd. The extremely high insecticidal power of this substance, especially towards lice, is noteworthy.

(4) 'Lauseto Neu'. The active principle of this German product represents a new type of insecticidal compound; it is chlorphenyl chlormethyl sulphone:



This compound is a crystalline solid (m.p. 118° C.), odourless and apparently of the same order of permanence as D.D.T. A sample was received from the Public Health Division of the British Control Commission for Germany. It was found to be more toxic to lice and bed bugs than D.D.T., but its use is limited by low solubility in refined mineral oils (about ½ per cent). The Germans used it in the form of a powder and also as dispersions and emulsions: they were in any event so short of oil during the War that kerosene could not be spared for insecticides.

The object of this communication is to direct wider attention to these new insecticides. Considerably more research must be done before sufficient data exist for choosing the most suitable for any particular use.

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Cause of Physiological Activity of 'Gammexane'

IT has been suggested by Slade[1] that the physiological activity of γ-hexachlorocyclohexane, the active constituent of the insecticide 'Gammexane', is due to its antagonism towards the essential metabolite *i*-inositol, which is considered to have the same spatial configuration. Kirkwood and Phillips[2] have recently shown that for the Gebrüder Mayer strain of *Saccharomyces cerevisiæ* this is in fact the case, since the γ-isomer has a marked inhibitory effect on the growth of the organism, and the inhibition is overcome by the addition of more *i*-inositol to the medium. The other three isomers of hexachlorocyclohexane are but slightly inhibitory, and excess *i*-inositol is without effect.

We had for some time been working with *Nematospora gossypii*, an ascomycete known to require exogenous *i*-inositol[3], and had observed a similar effect with the γ-isomer. Our findings, which support those of Kirkwood and Phillips, bear out the original suggestion of Slade. As an example, the results of one experiment are given:

Medium used: Glucose, 2 gm.; K_2HPO_4, 0·5 gm.; $MgSO_4.7H_2O$, 0·25 gm.; casein hydrolysate ('vitamin free'), to supply 0·25 gm. nitrogen; biotin (Glaxo), 0·1 mgm.; agar, 2 gm.; per 100 ml. medium. Cultures incubated at 30° C. for 7 days.

Wt. of *i*-inositol per 100 ml. medium	Wt. of mycelium, from pairs of plates, dried at 100° C. without added γ-isomer	with γ-isomer added to solubility limit
2 mgm.	90 mgm.	20 mgm.
4	122	42
6	154	74
8	178	132
10	190	180

With the β-isomer, no inhibition was found, but a very slight effect was noted with the α-isomer in a medium with a low *i*-inositol content. In a few tests in which hydrolysed gelatin was used as a source of nitrogen, the inhibitory effect of the γ-isomer was rather more marked.

There is some uncertainty concerning the solubility of γ-hexachlorocyclohexane in aqueous media. The American workers quote a figure of 60 μgm. per ml., whereas Slade gives 10 μgm. In our experiments, 10 mgm. of the compound, dissolved in 1 ml. ethanol, were added to 100 ml. of the medium. In view of the uncertainty as to the actual amount of the compound dissolving in the medium, and since complete inhibition of growth was not observed, the molecular inhibition ratio (McIlwain[4]) has not been calculated.

We are grateful to Messrs. I.C.I. (General Chemicals), Ltd., for generous gifts of the α-, β- and γ-isomers of hexachlorocyclohexane.

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Loss of Thiamin During the Baking of Bread

WE have just received the published account[1] of a symposium on "Factors Affecting the Nutritive Value of Bread as Human Food". An important issue not touched upon by the various speakers, but raised during discussion, concerned the loss of thiamin during the baking of bread. Two speakers expressed the view that in baking bread the loss of vitamin B_1 is slight. There are published data in support of this statement, but also a great deal of evidence to the contrary (see review by Holman[2]). The idea that little thiamin is lost during baking is surprisingly widespread, but is completely erroneous so far as breads made from very high extraction meals are concerned.

Using a thiochrome assay method[3], we have investigated the thiamin content of South African wheat-meals and the so-called 'Standard' bread introduced into this country early in the War. The bread is made from 'No. 1 Unsifted meal', originally of 95 per cent extraction but now approaching 100 per cent extraction. The mean values obtained in our survey are given below, together with some published British values for purposes of comparison.

Meal	Extraction (per cent)	Thiamin content (μgm./gm.)* Meal	Bread	Calculated loss of thiamin during baking (per cent)
British[4]	85	3·07	1·85	14·8
British[4]	85	3·00	1·83	16·8
British[4,5]	80	2·49	1·50	15·0
South African[3]	95	3·50	1·79	27·8

* Calculated to 11 per cent moisture for flour and 37 per cent moisture for bread.

It will be seen that South African 'Standard' bread, made from 95–100 per cent extraction meal, contains no more thiamin than the British 85 per cent extraction loaf. Yet the original meal is far richer in thiamin. On the assumption that the calculated loss of thiamin is entirely due to baking, and disregarding the other ingredients used in the loaf, it is clear that the destruction of thiamin in 'Standard' bread is almost twice as great as it is in the breads of lower extraction flours.

The greater loss of thiamin from high extraction wheatmeal may be attributed to the longer time required for baking. 'Standard' bread

requires 40–50 minutes baking, and often a little extra time is given it, in an attempt to prevent the subsequent development of 'rope'—a not infrequent occurrence in our climate. The oven temperatures are, if anything, a little lower for 'Standard' bread than for white bread which, however, requires only about thirty minutes baking. One is therefore led to the conclusion that it is the longer period of heating which brings about the greater degree of destruction of thiamin. Published data support this contention[7,8].

It follows from our findings that, while 'Standard' bread has some advantages over an 85 per cent extraction loaf, increased thiamin content is not one of them.

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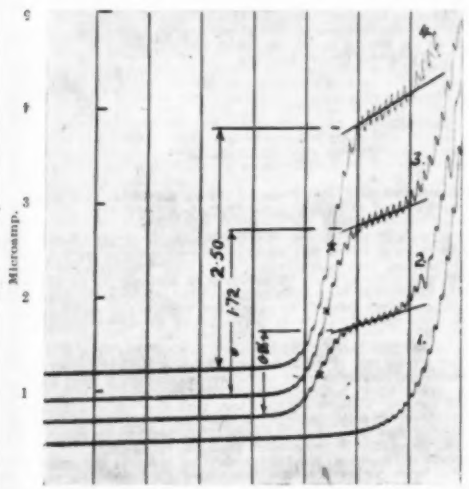
Polarographic Behaviour of Adenine

WORK in this laboratory on differences in mechanism between normal and malignant cells has shown the great need for improved methods of analysis and characterization of nucleic acids. Investigations which I began before the War indicated to me the value of the polarograph as an analytical tool in the study of inorganic cell constituents, and there was reason to believe that it had great possibilities in the organic field. Excellent accounts of general polarographic methods are now available[1,2].

Accordingly the behaviour of certain purine and pyrimidine bodies at the dropping mercury electrode was studied. Pech[3] had stated that compounds belonging to the purine group were not reducible at this electrode, with the exception of uric acid, which was reducible only after prolonged exposure to air in solution with lithium carbonate.

The present investigations show quite definitely that adenine, adenosine, adenylic acid and an adenine-cytosine dinucleotide are all reducible at the dropping mercury cathode and give well-defined diffusion currents or 'polarographic waves' when in solution in 0·1 *N* perchloric acid, and also in buffer solutions of perchloric acid and potassium perchlorate of similar concentration. Under the same conditions, no reduction occurs and no waves are obtained for guanine, guanosine, or guanylic acid, or for cytidine or cytidylic acid, or for uracil. Pure cytosine was not available and was not tested, but for reasons given later in connexion with adenine, it seems unlikely that cytosine will be reducible if cytidine and cytidylic acid are not. Thymine was not available for test, but as 5-methyl uracil it is unlikely to be reduced when uracil itself is not.



POLAROGRAMS OF ADENINE IN 0·1 *N* PERCHLORIC ACID AT 25° C., SHOWING CONSTANCY OF i_d/C AND VARIATION OF $E_{1/2}$ WITH CONCENTRATION. CONCENTRATIONS OF ADENINE: (1) ZERO, (2) $0{\cdot}50 \times 10^{-4}$ *M*, (3) $0{\cdot}99 \times 10^{-4}$ *M*, (4) $1{\cdot}48 \times 10^{-4}$ *M*. THE POINTS MARKED WITH A CROSS INDICATE HALF-WAVE POTENTIALS. THE CURRENT ZERO HAS BEEN SHIFTED FOR EACH TRACE

An extensive study was made of the reduction at the dropping mercury cathode of adenine, adenosine and adenylic acid. In all three cases the diffusion current (i_d) was proportional to concentration (C) over the ranges investigated, C being throughout of the order of 10^{-4} *M*. For adenine in concentrations between $0{\cdot}50 \times 10^{-4}$ *M* and $1{\cdot}96 \times 10^{-4}$ *M* the value of i_d/C was 17·0 μA./millimol. per litre for the particular capillary used and at 25° C. The value of i_d/C for the other compounds decreases with increasing complexity, that is, in the order adenine, adenosine, adenylic acid, and the adenine-cytosine dinucleotide. There is no systematic variation of i_d/C with *p*H for any of these compounds.

The half-wave potentials ($E_{1/2}$) are not constant but become more negative with increasing concentration. For adenine in perchlorate buffer of *p*H 1·30 at 25° C., $E_{1/2}$ varies from − 1·046 to − 1·073 volts ± 3 mV. *v.* the saturated calomel electrode over the concentration range $0{\cdot}50 \times 10^{-4}$ *M* to $1{\cdot}96 \times 10^{-4}$ *M*. Similar values are obtained for the other compounds.

The half-wave potentials vary in a linear fashion with hydrogen ion concentration, becoming increasingly negative as the *p*H increases. For adenine at a concentration of $0{\cdot}50 \times 10^{-4}$ *M* in perchlorate buffers of *p*H varying from 1·30 to 2·24, at 25° C., the value of $E_{1/2}$ changes from − 1·046 to − 1·129 volts ± 3 mV. *v.* the saturated calomel electrode. The other compounds behave similarly.

Temperature coefficients of both $E_{1/2}$ and i_d have been determined, and the values of the respective coefficients are similar for all three compounds.

The logarithmic plots of the waves of the three substances are very similar, log $i/(i_d - i)$ against $E_{d.e}$ being linear for the greater part of the wave. Calculations based on the slopes of these lines give fractional values for the number of electrons involved. For adenine $n = 1{\cdot}33$. This, together with the fact that $E_{1/2}$ varies linearly with *p*H, suggests that hydrogen ions are also involved. For a reversible reaction involving two hydrogen ions and two electrons, the plot of $E_{d.e}$ against log $(i_d - i)/i^2$ should be linear with a slope of 0·0295 at 25° C. All three substances give reasonably linear plots of $E_{d.e}$ against log $(i_d - i)/i^2$ over the whole wave, and the values of the slopes of these lines range from 0·026 for adenine to 0·029 for adenylic acid, in fair agreement with the theoretical value for such a reaction. The observed variation of $E_{1/2}$ with concentration is also to be expected from these linear plots. It must be pointed out, however, that the value of i_d/C for adenine is more than twice as large as the corresponding value for a divalent metal ion such as zinc, so that a larger number of electrons may be involved. Various experimental considerations point to the possibility of the reduction occurring at the double-bond linking nitrogen at position (1) with carbon at position (6) in the purine ring. It is thought that this reduction process may have considerable biological significance.

The evidence obtained shows that in all three substances, and presumably also in the adenine-cytosine dinucleotide, it is the adenine moiety which enters into the electro-reduction, and that the other adenine-containing compounds are so constituted that neither the sugar nor the phosphoric acid groups can prevent the reduction.

In conclusion, it is pointed out that the polarographic reduction of adenine enables it to be estimated quantitatively in the presence of any one or all of the other purine or pyrimidine bodies mentioned here. For quantities of the order of 1 microgram the accuracy of estimation is about ± 2 per cent, but it is possible to detect much smaller quantities than this. The method is of direct and simple application to the estimation of adenine in the hydrolysates of either ribose or desoxyribose nucleic acids. Work on these lines is being continued, and further details will be published later.

These investigations are being undertaken for the British Empire Cancer Campaign (Birmingham Branch).

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Utilization of Groundnut-Cake Hydrolysate as Medium for Production of Streptomycin

SINCE the announcement of the discovery of streptomycin[1] rapid progress has been made in the treatment of infectious diseases which are resistant to penicillin[2–5]. The studies of Schatz *et al.*[5] on the influence of the composition of the media on the production of the active agent by *A. griseus*, revealed that the formation of streptomycin requires the presence of a certain organic substance supplied by meat extract or corn steep liquor. The formation of streptomycin was not affected by the nature of the peptone used, though the addition of glucose increased the yield of the antibiotic. Recently, Le Page and Elizabeth Campbell[10] have found that yeast extract media fortified with minerals gives the most satisfactory production of the antibiotic with *A. griseus*.

For some time past we have been interested in the utilization of enzyme hydrolysate of groundnut-cake as a medium for the production of antibiotics from members of the Penicillium and Aspergilli groups. The encouraging results obtained with these led us to the study of the formation of the antibiotic from *A. griseus*.

Enzyme digest of groundnut-cake prepared under specific conditions was distributed in 5 ml. aliquots into sterile tubes 15 cm. long and 1·7 cm. in diameter and autoclaved at 15 lb. pressure for half an hour. The tubes were then inoculated with a spore suspension of *A. griseus*

EFFECT OF MEDIA ON THE FORMATION OF THE ANTIBIOTIC ACTIVITY BY *A. griseus* (WAKSMAN'S STRAIN)
Incubation temperature, 28° C. (mean)

Number of days after inoculation	Mean halo-diameter of duplicates in millimetres	
	Enzyme digest media	Schatz-Waksman media
1	Nil	Nil
2	12	"
3	10	"
4	13	"
5	16	10·5
6	17	13
7	10	14
8	Nil	14·5
9	"	13
10	"	13
11	"	Nil
12	"	"

and placed in a slanting position at an angle of 20°-30° so as to offer a large surface for growth. A similar experiment was carried out with Schatz-Waksman media. Antibiotic activity was determined[11] using *B. subtilis* as the test organism, at the end of every twenty-four hours, by drawing out tubes from the incubator. The results are summarized in the accompanying table.

The results in the table clearly show that the groundnut-cake hydrolysate contains the factors necessary for the production of antibiotic by *A. griseus*. As a matter of fact, in the case of the groundnut-cake hydrolysate, the presence of the antibiotic is detectable within forty-eight hours of inoculation. The maximum antibiotic activity is reached between the fifth and sixth day. After the sixth day the activity decreases rapidly until the eighth day, when no activity can be detected. In the case of Schatz-Waksman media the picture is entirely different. It is only between the fourth and the fifth day that the presence of the antibiotic is indicated. Maximum activity is reached between the eighth and the ninth day. However, in this case the destruction of the antibiotic after reaching the peak activity is more gradual than in the case of groundnut-cake hydrolysate. Thus it is seen that groundnut-cake hydrolysate can be effectively used in the place of Schatz-Waksman media. We are also investigating the amino-acid and vitamin requirements of *A. griseus* for the production of antibiotic activity. The detailed results of our investigation will be published elsewhere.

Our thanks are due to Prof. V. Subrahmanyan, Drs. N. N. De and K. P. Menon for their interest in our work. We gratefully acknowledge the generous support from the Council of Scientific and Industrial Research, Delhi, under the auspices of which this work is being carried out.

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Presence of Fibrinogen in the Yolk Sac Content of Rabbits

INVESTIGATIONS of the prenatal mortality in wild rabbits[1,2,3] led us to examine embryologically many 8-, 9- and 10-day embryos. It was found that in a substantial proportion of these the yolk sac content could be seen macroscopically to be gelatinous and to contain an irregular network of fine fibrils. Microscopic examination revealed the presence of a fine reticulum in the yolk sac. This reticulum resembled histologically sections of a fibrin clot prepared from blood plasma that had been fixed and stained by the same technique. For this and other reasons it was suspected that the reticulum in the yolk sac was, in fact, fibrin.

An attempt was made therefore to determine experimentally if fibrinogen was normally present in the yolk sac content of 9-day embryos of tame rabbits. The fluid was aspirated by means of a hypodermic syringe from the uterine swellings while the animal was under ether anæsthesia, and was citrated. By this means it was possible to obtain approximately 0·5 ml. from each 9-day embryo. Care was taken to avoid contamination of the fluid with blood, and any samples in which this occurred were rejected. It was impracticable to ensure that the fluid content of the yolk sac so withdrawn was not contaminated with traces of embryonic fluid from the exocœl or with tissue exudate from the uterine lumen, but it is certain that the amount of such contamination, if any, was small. A solution of human thrombin was then added to the aspirated fluid and resulted in the rapid formation of a clot in all cases.

It must be concluded therefore that fibrinogen is normally present in substantial amounts in the yolk sac content of rabbit embryos. The concentration is too great to be accounted for by the possible contamination of the yolk sac fluid with traces of other embryonic or maternal fluids. Since the vascular system of the embryo is in an early stage of development at this time, it is probable that the fibrinogen in the yolk sac is of maternal origin. It was possible to estimate that the concentration of fibrinogen in the aspirated fluid was of the order of 50 per cent of that in blood plasma by comparison of the clots formed in parallel series of dilutions of the yolk sac fluid and of blood plasma and by microanalyses.

It is hoped to publish a full account of this work elsewhere, and further investigations are in progress. We would like to take this opportunity of expressing our thanks to Dr. R. A. Kekwick for advising us on the hæmatological technique and to the Medical Research Council's Serum Unit at the Lister Institute for kindly providing us with the human thrombin employed. We are indebted to the Agricultural Research Council for financing the work of which this is a part.

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An Antibiotically Active and Slightly Pathogenic Member of the *Bac. brevis* Group Found in Man

A TWENTY-YEAR old male Arab was admitted to the Government Hospital, Haifa, and died two hours after admission. Post-mortem examination performed about one hour after death revealed as cause of death complete occlusion of the jejunum by multiple intussusceptions, obviously brought about by masses of Ascarids present in the small intestines. But in addition to this condition, all lymphatic glands in the mesentery were found to be considerably enlarged and hard. The liver was slightly enlarged, the spleen showing no abnormality. Histologically, the mesenteric glands showed a marked disruption of their architecture; there was partial destruction of the lymphatic tissue with replacement by reticulo-endothelial hyperplasia, suggesting an inflammatory process of some duration. There were no signs of tuberculosis. Small necrotic foci were found in the liver.

In smears from the enlarged glands, no acid-fast organisms were found, but numerous capsulated Gram-negative bacilli were present. By culturing the glandular fluid on blood agar plates, rich pure cultures of these bacilli were obtained which, on further examination, proved to belong to the *Bac. brevis* group. They were non-pathogenic for rabbits and guinea pigs.

In the agar-plate test the strain inhibited the growth of *Staphylococcus aureus*, α- and β-hæmolytic streptococci, pneumococci and *P. pestis*. There was no inhibitory effect upon members of the typhoid-coli group and on the inhibiting strain itself.

Antibiotically active cell-free watery extracts could be prepared from cultures on Dorset's egg medium (which is liquefied by the bacillus) and from surface cultures on peptone-water. These extracts caused lysis, at *p*H 7·0–7·2, of all the organisms inhibited in the plate experiment and also of its own parent strain and of cultures of *Paramecium caudatum*.

The active principle is soluble in water, ethyl and *n*-butyl alcohol, but insoluble in ether, petrol ether and carbon tetrachloride.

The peculiar features of this strain are its origin, its pathogenic effect on the human lymphatic tissue, and the apparent difference of its active principle from tyrothricin.

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Resolution and Synthesis of Virus Complexes Causing Strawberry Yellow-edge

PRELIMINARY experiments on the resolution of strawberry virus complexes have shown that, after feeding for twenty-four hours on a plant infected with 'yellow-edge', the vector *Capitophorus fragariæ* Theob. transmits a single virus which is believed to be the 'mild crinkle' virus. This virus is transmitted after infection-feeding periods of 1 hour or more, persists for only a few hours in the vector and produces faint chlorotic spots on the leaves of Royal Sovereign strawberry[1].

Work by Wood and Whitehead at Bangor[2] has shown that two distinct viruses (one of which is more persistent than the other) can be isolated from plants infected with 'severe crinkle'. I have shown in more recent work that a persistent virus can also be isolated from plants infected with yellow-edge and that this virus is apparently distinct from the persistent virus of Wood and Whitehead. It has now been found that the combined action of the two viruses isolated from a plant infected with yellow-edge produces yellow-edge.

Aphids (*C. fragariæ*) fed for ten days on a Royal Sovereign plant infected with yellow-edge are transferred to uninfected plants of *Fragaria vesca*, and after feeding there for twenty-four hours are retransferred to a second series of uninfected *F. vesca* plants. The plants of the second series do not become infected with the 'mild crinkle' virus (since this virus does not persist in the vector), but a number of them develop symptoms of a mild type, namely, chlorotic spotting often accompanied by slight cupping of the leaves.

The virus producing these symptoms is retransmitted after infection-feeding periods of twenty-four hours or more, persists in the vector for several days and produces very mild and scarcely distinguishable symptoms of the yellow-edge type on Royal Sovereign strawberry. It is thus distinct from the mild crinkle virus already isolated, and will

be provisionally referred to as the 'mild yellow-edge' virus. When a Royal Sovereign plant infected with one of these viruses is grafted to one infected with the other, both plants develop severe yellow-edge symptoms.

It follows from these observations that yellow-edge is caused by the combined action of two distinct viruses (the mild crinkle virus and the mild yellow-edge virus), which can be separated by making use of differences in their vector relationships.

This conclusion does not, however, exclude the possibility that other viruses or combinations of viruses may also cause yellow-edge. Thus I have also found that a persistent virus (probably identical with the persistent virus of Wood and Whitehead) can be isolated from plants infected with 'severe crinkle'. This virus is transmitted by *C. fragariæ* after an infection-feeding period of ten days, persists in the vector for several days and, by itself, produces symptoms of the severe crinkle type on Royal Sovereign. The combination of this virus with the persistent virus isolated from a plant infected with yellow-edge, as described above, also produces severe yellow-edge.

Two etiologically distinct types of yellow-edge have therefore been synthesized, each produced by a pair of viruses, the pairs having the mild yellow-edge virus in common. The second virus is, in one case, of the mild crinkle type and, in the other, of the severe crinkle type. The frequent occurrence of crinkle in association with yellow-edge has already been noted in grafting experiments[3], but the obligate nature of this association had not previously been demonstrated.

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Magnesium Chlorosis of Tomatoes

THE summary in *Nature*[1] of the paper by Walsh and Clarke[2] directs attention to the methods of treating tomato plants affected by induced magnesium deficiency. The paper emphasizes the importance in this connexion of the potash level in the soil, a relationship which was previously described by Cromwell and Hunter[3], and a review of the position may be timely.

Jones, Nicholas and Wallace[4], and Jones, Nicholas, Wallace and Jefferiss[5], stated that good control of magnesium deficiency in tomatoes was obtained by heavy applications of magnesium sulphate to the soil. Similar treatments given during several years in south-western Scotland have been ineffective.

In sand-culture experiments conducted in this College, absorption of magnesium decreased with increasing concentration of the solution in which the plants were growing; this effect of concentration was as important as was the ratio of ions in the solution: when the solution was relatively concentrated and also the ratio of potassium to magnesium in it was high, then the absorption of magnesium was most restricted and the chlorosis was most severe. The conductivity of soil surrounding chlorotic plants was always found to be high, and usually to be higher than that of neighbouring soil bearing healthy or less severely affected plants. A critically high concentration of soluble salts in the soil would thus probably be harmfully increased by applications of magnesium salts.

It has already been pointed out by Cromwell and Hunter[3] that this type of chlorosis may also be caused by factors other than the potash status of the soil.

In sand-culture and glasshouse work in this College, induced chlorosis in tomatoes was associated particularly with the use of potassium sulphate as a fertilizer, though excessive applications of other potassic fertilizers also induced the deficiency. The effect of potassium sulphate probably arises from the different rates of absorption of its ions. The chlorosis was not increased by raising the sulphate content of the tomato soils or sand-cultures above the normal level by means of sodium sulphate or calcium sulphate, the amounts of other fertilizers applied being adjusted to keep the concentration of soluble salts approximately constant.

That control of the chlorosis may be obtained by repeatedly spraying the foliage with magnesium sulphate solution has been reported by Jones, Nicholas, Wallace and Jefferiss[5], and control was obtained in this area when the plants were sprayed sufficiently often. It seems unlikely that spraying treatment will have practical value in the West of Scotland College area.

Several different types of soil cultivation for glasshouse tomatoes have been investigated at the College, but none was found effective in controlling the chlorosis.

Results obtained this season by, for example, early mulching with farmyard manure or peat suggest, however, that an encouragement of secondary root production may go far to offset the conditions under which induced magnesium deficiency appears.

This work has been done by co-operation between the Departments of Chemistry and Horticulture at the College.

Until new cultural methods have been fully investigated, the cure for induced magnesium deficiency, if it persists when the potash dressings are kept as low as possible, seems to lie in resoiling, and, taking into account the other advantages of resoiling, this may be economic.

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Aphosphorosis and Phosphate Reserves

THE solid rock substratum of County Offaly is almost exclusively Carboniferous limestone without igneous intrusions, overlain by extensive patches of bog land and glacial limestone drift. The aphosphorosis in Offaly cattle described by Prof. E. J. Sheehy[1] may be a permanent characteristic of certain areas; but during recent years the annual loss of tricalcium phosphate through the export of cattle from Eire has been of the order of 25,000 tons[2] in contrast to the 17,000[3,4] mentioned for New Zealand. This has not been restored to the soil. The normal imports, seriously reduced during the war period, are about four times as great. The drain on phosphorus from the soil is also being considerably aggravated by increased tillage, although the emergency production of phosphorite from West Clare[5] has offset this to a limited extent. There must therefore be certain areas where the rate of release of phosphorus from the rock via the soil into the vegetation can no longer keep pace with the demand, and where accordingly there will be created a deficiency in available phosphorus for years, unless it is artificially replaced. Significantly, this is reported from old pastures. The temporary restriction of phosphate imports would be of less account, but for the constant irreversible loss through the cattle export trade.

The phosphorus balance-sheets of those countries now exporting food will evidently require careful watching.

The somewhat unusual Carboniferous phosphorite deposits of West Clare, on which a preliminary note[5] was published in 1942, are to be described in greater detail elsewhere. They occur as thin flat lenses interbedded in black shales a few feet above the top of the Upper Carboniferous limestone, and are considered to have been deposited in shallow salt water not far from the land surface which provided the first outrush of Millstone Grit sediments into the crinoidal limestone sea. The shales were associated by Wheelton Hind[6] with equivalent beds in England and at Chokier in Belgium. The phosphorite lenses are by no means easy to locate, and while search in Ireland has been unsuccessful outside Co. Clare, it may still be worth while to conduct a careful examination of similar facies of this particular horizon in more distant areas.

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A New *Rh* Allelomorph

A CELL sample from a blood donor (*Abe* — —) was found to be of Group *O* Rh_1rh. That is to say, the blood was agglutinated by anti-*c*, anti-*E* and anti-*e*, but not by anti-*C* sera: the result with anti-*D* serum was variable. While the agglutination of this blood sample by certain anti-*D* sera was strong, using others it was weak, with only a few cells being clumped, and some gave completely negative results.

This suggested the presence of a new allele D^U at Fisher's *D–d* locus. The donor's cells would, therefore, be cD^UE/cde. This hypothesis is supported first by an examination of the donor's family, which showed the erythrocytes of the father and two brothers to be of the same type, and secondly by the discovery of two cell samples of the type CD^Ue/cde, and one of type CD^Ue/CDe[1].

Cells	Dilution of serum							
	Anti-*D* (i)							
	1	2	4	8	16	32	64	128
R_1r'. (*Abe* — —)	+	+	+	+	+	+	—	—
R_1r. (*Ba* — —)	+	+	+	+	+	+	+	—
	Anti-*D* (ii)							
R_1r'. (*Abe* —)	—	—	—	—	—	—	—	—
R_1r. (*Ba* —)	+	+	+	+	+	+	+	—

Thirty-two strong anti-*D* sera were tested against the donor's cells. Twelve tests were found to be positive, exhibiting agglutination of variable intensity. Twenty of the sera completely failed to agglutinate the cells, but some contained blocking antibodies to the donor's (*Abe* — —) cells. Typical results are shown in the accompanying table. Anti-*D* blocking antibody will apparently prevent the agglutination of the donor's cells by anti-D^U agglutinins.

All anti-D^U sera used so far are mixtures of anti-*D* and anti-D^U. Adsorption of anti-*D* + anti-D^U has not resulted in the production of a pure anti-D^U agglutinin. Attempted immunization of two persons both *Rh*-negative (the one having anti-*D* and anti-D^U and the other no agglutinins in the serum) with the donor's cells failed to produce an anti-D^U serum or to increase the titre of anti-D^U.

The above findings can only be properly assessed in terms of Fisher's hypothesis. It is especially helpful to consider closely the analogy with C^{w}[1,2]. In this case it was shown that previously known anti-*C* sera were of two classes, a pure anti-*C* and one consisting of mixtures of anti-*C* and anti-C^w. The ability of the antigen *C* to provoke either a pure anti-*C* serum or anti-*C* + anti-C^w showed a chemical similarity between the antigens and was perhaps in favour of C^w being an allele of *C*. Furthermore, the antigen C^w was shown to be inherited as part of a complex C^wDe. The reactions of individual heterozygotes such as C^wDe/cde could be interpreted in terms of C^w being an allele of *C*, but could equally be due to an antigen produced by a fourth closely linked locus (say, *F*). It could, however, be shown that as the new antigen was passed on from one generation to the

next it was not linked with *C* or *c* but replaced one of them. Finally, a homozygote C^wDe/C^wDe was found not to react with either pure anti-*C* or anti-*c*, and this very clearly showed that *C*,*c* and C^w were alleles.

The evidence so far available in the case of D^U shows a complete analogy with the facts known about C^w, and approaches definite proof that D^U is an allele of *D* and *d*. For a complete proof it will be necessary to have available an anti-*d* serum and either a pure anti-D^U serum or homozygous D^U/D^U cells.

When sera containing anti-*D* but not anti-D^U are used in routine typing, occasional cell samples will be put in the Rh' or Rh'' class which with the mixed type of serum would be classified as Rh_1 or Rh_2, with D^U in place of *D*. The results given for Rh' and Rh'' frequency by me[2] were determined using an anti-*D* plus anti-D^U serum. The frequency of D^U is unknown but seems likely to be low.

These donor's cells form an excellent medium for establishing the presence of blocking antibody in sera which also contain anti-*D* agglutinin. This assists in correlating findings in maternal sera with the severity of hæmolytic disease in affected children. In some severe cases of hæmolytic disease the maternal sera contained low-titre anti-*D* agglutinins. Re-examination of such sera with the donor's cells, while showing no agglutination, revealed strong blocking antibodies.

This allele D^U may also be similar to certain 'intermediate' genotypes described by Wiener[4].

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New Evidence for the Formation of Molecular Complexes in Monolayers by Penetration

THE formation of complexes of definite composition in monolayers as described by Schulman and Stenhagen[1], in particular with cetyl alcohol and sodium-cetyl sulphate, has been questioned by Harkins[2]. Harkins did not succeed in reproducing the discontinuities on the isotherms and has expressed doubt about the existence of the corresponding complexes and the validity of the experimental results in general. In fact, the shape of the isotherms is a function of time, on account of the instability of the monolayer (collapse or solubility); it is possible to notice changes of behaviour, of rate of collapse, of stability and of physical state, but without much precision about the molecular areas corresponding to the different regions. I have taken up again this question of the interaction in monolayers between cetyl alcohol and sodium alkyl sulphates using a slightly different technique which removes any doubt about the existence of the 1-1, 1-2 and 1-3 complexes.

The cetyl alcohol layer is spread on phosphate buffer *M*/300 at *p*H 8 and kept under constant pressure of 23 dynes/cm., by using triricinolein as piston oil. When the sodium-cetyl sulphate is injected, the area of the monolayer increases with time, passes through a maximum, then decreases to a constant value nearly double that occupied by the alcohol alone. The complex formed is of the type 1-1, and is solid and stable under 23 dynes.

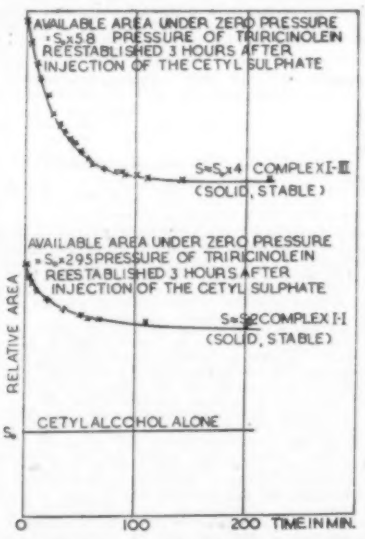

Fig. 1. VARIATION OF THE AREA OF MIXED FILMS OF CETYL ALCOHOL + SODIUM-CETYL SULPHATE WITH TIME. $T = 17°$, $pH = 8$ (*M*/300 PHOSPHATE)

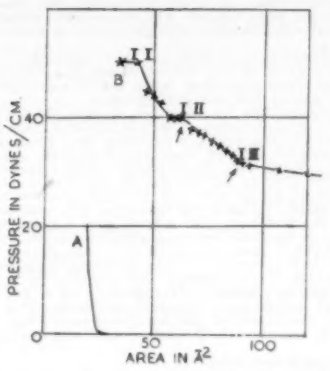

Fig. 2. *A*. COMPRESSION ISOTHERM OF CETYL ALCOHOL. *B*. CETYL ALCOHOL FILM PENETRATED BY SODIUM-CETYL SULPHATE. COMPRESSION ISOTHERM 3 HOURS AFTER EQUILIBRIUM PRESSURE AT LARGE AREA HAS BEEN REACHED. MEASUREMENTS TAKEN CONSECUTIVELY EVERY TWO MINUTES

Alternatively, if after forming the film of cetyl alcohol and measuring its area under the pressure of triricinolein, one expands it over a large surface before injecting the cetyl sulphate and re-establishes the pressure only after a few hours, the following facts are observed.

If the quantity of injected cetyl sulphate is relatively large (10 γgm. per litre), and if the available surface under negligible pressure is large (that is, six times the area occupied by the alcohol under the pressure of triricinolein) when the pressure is re-established, the area diminishes and settles at a value of four times the original area of the cetyl alcohol, the film being solid and stable below a pressure of 30 dynes: the complex is of the type 1-3 (Fig. 1).

It should be pointed out that if the available surface is not sufficient for the formation of the 1-3 complex, even with an excess of cetyl sulphate the area is reduced to the 1-1 complex, without the complex 1-2 being formed. This latter complex is not stable and is never formed spontaneously.

Information can nevertheless be obtained on the 1-2 complex in the following way: after forming the 1-3 complex, the pressure is increased by a given quantity and the variation of area is plotted against time. Definite changes of rate are shown at areas corresponding to the 1-2 and 1-1 complexes. The 1-2 complex is never obtained in a stable state, and even the 1-1 collapses in its turn if the pressure is high enough. Furthermore, if starting from the 1-3 complex which has been kept stable for 2-3 hours, an isotherm is established very rapidly, very abrupt changes of slope are noticed corresponding to the 1-2 and 1-1 complexes (Fig. 2). Identical results were obtained with sodium lauryl sulphate.

This method is of general use and has permitted us to study a very great number of pairs of substances giving complex monolayers in stoichiometrical proportions[3]. It should be emphasized that the formation of a complex can be established only if a range of pressure is found in which the mixed monolayer is relatively stable, that is, when the rate of collapse of the mixed monolayer is lower than that of the adsorbed layer of the soluble constituent alone under the same pressure. It is obvious that an adsorbed layer of the soluble constituent alone cannot withstand a pressure above its equilibrium pressure without dissolving. Thus the stability of the penetrated monolayer under a pressure above the proper pressure of the soluble constituent can be taken as a test for distinguishing a complex from an ordinary mixture. This evidently does not obviate the necessity of definite proportions between the constituents.

As a general rule, before injecting, the insoluble layer should be sufficiently expanded so that its pressure does not impede the adsorption and penetration of the soluble substance. In some cases, however, when the injected substance is very capillary-active, the insoluble layer must be maintained under sufficient pressure not to be displaced by the adsorption layer, and furthermore, the injection should be done very slowly. This is the case, for example, with lecithin and sodium lauryl sulphate complexes: working with caution, 1-4, 1-3 and 1-1 complexes are formed. Another indispensable precaution is to allow enough time to elapse (one or two hours) between the injection and the measurement: adsorption is sometimes very slow and the formation of the complex may also be very slow. For the area ascribed to the complexes, one should take the limiting value of the area as it decreases under constant pressure with increasing time. If sudden changes in the slope of this curve occur, areas corresponding to the transition points must be ascribed to the formation of successive complexes. This method enables one to find without any ambiguity, for the same pair of substances, complexes corresponding to a series of definite proportions. This can be illustrated by the following examples:

Lysolecithin + sodium palmitate: 1-1, 1-2, 1-3 solid complexes.
Lecithin + digitonin: 1-1, 1-3, 2-3 liquid complexes.
Heptadecylamine + digitonin: 2-1, 1-1, 2-3, 1-2 liquid complexes.

A simple explanation can be given for the unsuccessful trials encountered by the isotherm method. During the compression, mixed monolayers are, in most cases, in a metastable state. There is some sort of hysteresis in the reversibility of the formation of the complexes. On one hand, it is often found that a complex is apparently stable at a pressure higher than that under which it can form spontaneously. On the other hand, frequently a complex begins to be unstable at a

pressure lower than that which would be necessary to squeeze out the soluble constituent. The phenomena are more complicated when the two associated substances are liable to give several complexes, for example, 1–1 and 1–2. Suppose the 1–2 complex is formed; and then we try to obtain by compression the 1–1 complex. Very often, the squeezing out of one molecule of the soluble substance from the 1–2 complex requires a pressure at which the 1–1 complex is no longer stable; hence it is impossible with the isotherm method to determine the molecular area relative to the second complex, this remaining unobserved.

I should like to thank Dr. D. G. Dervichian for much stimulating criticism and advice.

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Electric Induction in Molecules and the Polarity of the C—H Bond

For non-mesomeric molecules the molecular electric moment may be formally divided into the vector sums of the group moments and of the induced moments. Calculation of these latter has been attempted by Smallwood and Herzfeld[1], Smyth[2] and Groves and Sugden[3]; but the number of examples of any one molecular type considered has been too small to substantiate the methods. The calculations of the last-named authors, based on a method suggested by Frank[4], appear to be the most valid.

The known or determinable geometry of ethylene oxide and its homologues, and the analogous sulphides and imines, makes these compounds particularly suitable for calculating electric induction within molecules. The dipole moments of the cyclic ethers are known with a fair degree of accuracy and are shown in the accompanying table. These values have been used in the preliminary calculations outlined below.

The original Groves–Sugden model is over-simplified in that methyl and methylene groups are treated as carbon atoms with the polarizability proper to the groups. This implies a polarization symmetry which the group does not possess, and accordingly the induced moment has now been computed separately for every atom in a molecule (Model 1). Equations are obtained relating the molecular moment, the group moments $\mu(CH_2 - O)$, $\mu(H - C)$ and the induced moment. Mutual solutions of these equations give simultaneous values of the group moments which average: $\mu(CH_2 - O) = 2{\cdot}05$ D., $\mu(H - C) = -0{\cdot}46$ D. Substitution of the latter value in the equations yields the individual values of $\mu(CH_2 - O)$ shown in the table.

Variation of polarizability with type of bond implies that the quantity depends chiefly on the bonding electrons. The Groves-Sugden model assumes that these electrons are symmetrically distributed over a spherical surface defined by the atomic covalent radius. The fact of directed valence indicates a localization of polarizable material. Accordingly a new model (Model II) has been used in which the bonding electron pair between two atoms is concentrated at the 'point of contact' of spheres with the appropriate covalent radii. Bond polarizabilities[5] are now employed, allowance being made in the case of the $CH_2 - O$ group for the unbonded electrons. Equations similar to those derived from Model I lead to average values of the group moments: $\mu(CH_2 - O) = 1{\cdot}83$ D., $\mu(H - C) = -0{\cdot}41$ D. Individual values of $\mu(CH_2 - O)$, obtained as before, are shown in the table.

In reality, there is neither a spherically symmetrical nor a point distribution of valency electrons. These are extremes, somewhere between which is the most probable configuration. For the ethylene oxide molecule, in which the two group moments are most closely juxtaposed, there is clearly under-compensation for the induced moment by Model I and over-compensation by Model II. For these two reasons the mean values of the group moments (see table) are taken to be approximately correct. The average of these gives $\mu(CH_2 - O) = 1{\cdot}93$ D., and correspondingly $\mu(H - C) = -0{\cdot}43$ D.

	Molecular moment μ	Group moment $\mu(CH_2 - O)$		
		Model I	Model II	Mean
		Debye units		
Ethylene oxide	1·88[6]	1·58	2·02	1·80
Trimethylene oxide	2·01[6]	2·15	1·72	1·94
Tetramethylene oxide	1·71[7]	2·20	1·74	1·97
Dimethyl ether	1·28[8]	2·20	1·80	2·00

The magnitude of the moment of the C — H bond was determined by Timm and Mecke[9] as ~ 0·3 D. and by Rollefson and Havens[10] as 0·31 D. from measurements of refractive indices in the infra-red region. It has been calculated by Coulson[11] to be 0·4 D. The result of the present investigation is, therefore, in fair agreement.

The sign of the moment has caused some controversy. Smyth[12] supports the view that the polarity is $\overset{-}{C} - \overset{+}{H}$, chiefly on the grounds that the parallelism of electronegativity difference and bond moment demands such a relation. A calculation by Hirschfelder reported by Smyth appeared to substantiate the position, but Coulson[11] has shown that the treatment is incorrect and that, in fact, application of the method of molecular orbitals to methane leads to the polarity $\overset{+}{C} - \overset{-}{H}$. The calculations reported here also indicate this charge distribution.

An attempt is being made to formulate a more adequate model than either of those used, and the measurement of the dipole moments of the cyclic oxides, sulphides and imines in the vapour phase is in progress. Details of the calculations outlined above will be published elsewhere in due course.

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The Three Coefficients of Viscosity of Anisotropic Liquids

Before and during the War, investigations were reported on the viscosity of anisotropic liquids[1,2,3,4,5]. As is well known, the flow of an anisotropic liquid influences the orientation of the molecules. On the other hand, the value of the viscosity coefficient depends on this orientation. Therefore this coefficient is a function of the velocity-gradient, and the usual definition of the viscosity coefficient for these liquids loses its significance. If under the influence of any factor the molecules of the liquid should be orientated in one direction and the motion is unable to change this orientation, then we have the viscosity coefficient in the ordinary sense. But in this case we have to deal with the anisotropy of the viscosity, and in case of a liquid of the type of *p*-azoxyanisol we have three principal viscosity coefficients belonging to the three directions of orientation; these are: (1) direction of the flow; (2) direction of the velocity gradient; (3) perpendicular to both these directions. Having given the molecules an orientation by means of a magnetic field in such circumstances that the flow did not change this orientation, I obtained the following values for the three principal viscosity coefficients for *p*-azoxyanisol and *p*-azoxyphenetol[2].

Substance and temperature	Molecules parallel to the direction of the flow, η_1	Molecules parallel to the gradient of velocity, η_2	Molecules perpendicular to the direction of flow and to the velocity gradient, η_3
p-Azoxyanisol 122° C.	0·024 ± 0·0005	0·092 ± 0·004	0·034 ± 0·003
p-Azoxyphenetol 144·4° C.	0·013 ± 0·0005	0·083 ± 0·004	0·025 ± 0·003

These results throw light on those obtained by the other investigators. The results of the older investigators (Eichwald[2] and Dickenschied[6]) obtained by the method of flow through capillary tubes are in agreement with my results. Evidently, in both cases we were dealing with the orientation of molecules parallel to the direction of flow. Zwetkoff and Michajlow[3], using the method of flow through a tube with rectangular cross-section, by application of the strongest available magnetic field and with the smallest possible velocity of flow, obtained values about 80 per cent of my value, η_2. From the dependence of the results on the intensity of the magnetic field, it is clear that these investigators did not reach the state of constant orientation of molecules, and that the flow of the liquid changed this orientation. The results obtained by these authors for the different values of velocity and for different intensities of magnetic field lie between η_1 (orientation parallel to the flow) and η_2 (parallel to the velocity gradient) $\eta_1 \leq \eta_{Zwetkoff} < \eta_2$.

The measurements recently published by Becherer and Kast[4] were not carried out with constant orientation of the molecules. They were, however, orientated (at least in the layers where the phenomenon of viscosity chiefly takes place) in the planes of friction, but without a definite angle in this plane. The value obtained by these investigators is therefore not one of the three principal coefficients in the sense given by me. Clearly, $\eta_1 < \eta_{Kast} < \eta_2$, because in my measurements of η_1 and η_2 we have also an orientation parallel to the plane of friction, but once parallel and then perpendicular to the direction of the flow.

Hence the coefficient η_1 was measured by other workers as well as by me. The method of flow through capillaries gives usually the result corresponding to an orientation of molecules in the direction of flow; the other values given by different investigators do not correspond to constant orientation of molecules.

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Photovoltaic Effects Exhibited in High-resistance Semi-conducting Films

MICROCRYSTALLINE layers of lead sulphide have been obtained which, after suitable activation, exhibit photovoltaic effects of a new type.

The photosensitive layer consists of a film about 1 micron in thickness deposited on glass between graphite electrodes a few millimetres apart. When illuminated by infra-red radiation of wave-length between approximately 1 and 3·5 microns, a photo E.M.F. is developed between the electrodes. It has been shown that this effect is independent of the contacts between the semi-conductor and the electrodes, and is due to the internal properties of the sensitive material. Cells with resistance of a few megohms and photo E.M.F. reaching 2 volts have been produced. These cells, as might be expected, show pronounced rectifying properties, the ratio of conductivities for opposite directions of current being about 100 : 1 at room temperature. The photo current is always in the direction of high resistance.

The cells were produced as a result of information obtained during development work on the photoconductivity of activated thallium sulphide and lead sulphide layers. It is generally accepted that conductivity in semi-conductors is associated with the presence of impurity centres in the crystalline lattice. The impurity centres may be either electro-positive or electro-negative, giving rise respectively to 'electronic' or 'hole' components of conductivity. Consideration of our results obtained from sensitizing treatments in oxygen and *in vacuo* leads to the conclusion that impurity centres of either sign may be introduced, and further support is given to this by measurements of the Hall coefficient. High conductivity due to the presence of impurity of one sign alone is not associated with photosensitivity. The best photoconductivity in a given layer appears when maximum resistance is obtained, which may be explained by the existence of some kind of equilibrium between impurity centres of both signs which are simultaneously present. Also the experimental results are best explained by the assumption that the positive and negative centres are not uniformly distributed and that variations in relative concentration are closely associated with the microcrystalline structure of the layer, some of the crystals having a concentration of centres of a given sign different from their neighbours.

A semi-quantitative model was developed which postulated the existence of barriers at the boundaries of the crystals, with unequal concentration of impurity centres on opposite sides. The properties of normal photoconducting layers could be explained by random orientation and distribution of these barriers, but the possibility also arose of orientating them to produce a resultant photovoltaic effect from the cell. Such a cell, because of the superposition of the effects of many individual elements in series, should be strongly rectifying and, unlike the usual photovoltaic cells, should have a high resistance and high voltage sensitivity.

The treatment which was successful in producing photovoltaic cells of this kind consisted in passing a current through the photoconducting film at a temperature sufficiently high to ensure mobility of oxygen ions (about 250° C.). The direction of the resultant photo E.M.F. is in the opposite sense to the activating current. Layers treated in this way also show a marked directional photoconductivity : the conductivity in the high-resistance direction is strongly increased by illumination, and in the low-resistance direction the increase is less pronounced.

Under certain conditions, non-uniform activation across the cell may be obtained ; and it is found that the photovoltaic and photoconductive sensitivity are always associated with the same part of the layer, as would be expected from the above considerations. Also in exceptional cases the sensitive area can be displaced across the layer towards the positive electrode, indicating the mobility of negative centres and a fairly uniform distribution of positive centres.

A full description of the experimental work and a more detailed development of the theoretical considerations will be given elsewhere.

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Surface Area Determination

IN the determination of surface area using nitrogen at the temperature of liquid nitrogen by the method of Brunauer, Emmett and Teller[1], it is usual to determine the dead-space on each sample, using helium. For routine determinations on a substance known to give *S*-shaped isotherms, that is, where the equation of Brunauer, Emmett and Teller is applicable, it is possible to avoid this dead-space determination. If V_1 c.c. nitrogen are adsorbed at a pressure p_1, then the dead-space is given by

$$p_1 (1 + \alpha)D \simeq p_1 D,$$

where D is dead-space at unit pressure and α is a correction factor equal to $6{\cdot}58 \times 10^{-4}$ at unit pressure. Hence, if V_{c1} is volume of nitrogen in the sample bulb, then

$$V_1 = V_{c1} - p_1 D\,; \quad V_2 = V_{c2} - p_2 D\,; \quad V_3 = V_{c3} - p_3 D.$$

It follows that

$$V_1 = V_{c1} - p_1 \left(\frac{V_{c3} - V_3}{p_3}\right).$$

Emmett[2] points out that a line drawn through the origin and one adsorption point at a relative pressure of *c.* 0·3 usually differs in slope by less than 5 per cent from that drawn using several adsorption points.

If this is assumed, then

$$V_1 (p_0 - p_1) = V_2 (p_0 - p_2) = V_3 (p_0 - p_3).$$

Therefore

$$V_1 = V_{c1} - \frac{p_1}{p_3}\left(V_{c3} - V_1 \cdot \frac{p_0 - p_1}{p_0 - p_3}\right)$$

Rearranging,

$$V_1 = \frac{V_{c1} - V_{c3}\dfrac{p_1}{p_3}}{1 - \dfrac{p_1}{p_3}\left(\dfrac{p_0 - p_1}{p_0 - p_3}\right)};$$

and similarly for V_2.

In the plot of p/p_0 against $\frac{p}{V(p_0 - p)}$, the monolayer volume V_m is the reciprocal of the slope, that is,

$$V_m = \frac{(p_2 - p_1)/p_0}{p_2/\{V_2(p_0 - p_2)\} - p_1/\{V_1(p_0 - p_1)\}}. \quad (1)$$

This involves determining three adsorption points, but no dead-space; a slightly less accurate value can be found using only two points, that is,

$$V_m = \frac{p_1/p_0}{p_1/\{V_1(p_0 - p_1)\}} = \frac{V_1}{p_0}(p_0 - p_1).$$

In neither case is it necessary actually to plot the points.

Areas determined on various substances by the usual technique, that is, involving a dead-space determination, are compared with those obtained by recalculation using equation (1) above in the following table:

Substance	Area in sq. m./gm.	
	By dead-space determination	By recalculation
Carbon *A*	790	753
Carbon *B*	847	840
Carbon *C*	814	800
Carbon *D*	460	460
Carbon *E*	280	282
Chalk *A*	30	29
Chalk *B*	19	19
Paris White	2	2
Clay	10	10
Asbestos	18	14

It will be noted that the calculated areas are generally lower than the dead-space areas, that is, the slopes are too great : this is in accordance with the assumption made above.

Our thanks are due to the directors of the Washington Chemical Company, Ltd., for permission to publish this note.

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[1] Brunauer, Emmett and Teller, *J. Amer. Chem. Soc.*, **60**, 309 (1938).
[2] Emmett, P. H., "Symposium on New Methods of Determining Particle Size in Subsieve Range", *Amer. Soc. Test. Mat.*, p. 95 (March 1941).

An Optical-Acoustic Method of Gas Analysis

Bell, Tyndall and Röntgen all knew that gases and vapours absorb infra-red rays and that they would produce sounds if a stream of rays was interrupted at sonic frequencies. The mechanism of this phenomenon is as follows. When a gas absorbs infra-red rays, it is heated and its pressure increases. If the stream of radiation is interrupted at sonic frequency, there are rapid changes of pressure in the gas. Pulsation takes place, which is nothing more nor less than sound. The pitch of the sound depends on the frequency at which the rays are interrupted, and its strength on the ability of the gas to absorb infra-red rays. If pure air, in which there are no extraneous gases or vapours, is submitted to interrupted irradiation with infra-red rays, there will be no sound, since oxygen and nitrogen, of which the air is composed, do not absorb infra-red rays. If the rays are passed through a mixture of air and a gas or vapour, the sound produced will be louder the greater the quantity of extraneous matter present in the air.

Tyndall first spoke of using this phenomenon to detect gases in mines so early as 1888. He had at his disposal no instrument with which to measure the strength of sounds, and could not therefore put his idea into practice. The idea of using interrupted infra-red rays for this purpose was forgotten until 1937, when I developed my optical-acoustic gas analyser, involving the use of modern reception and measuring instruments. This analyser will determine the quantitative composition of a gas mixture the qualitative content of which is already known. The method is almost universal and will detect all gases except oxygen, hydrogen and nitrogen, which do not absorb infra-red rays.

The principle of the analyser is, briefly, as follows : Infra-red rays are emitted by an electrically heated platinum ribbon in a closed box with a window through which rays pass. They are inter-

cupted two hundred times a second by a revolving disk with an aperture in it. These rays are directed into the gas chamber containing the mixture to be tested. The chamber has a window at one end to admit rays and a microphone at the other. When infra-red rays enter the gas mixture, its pressure is increased by heat generated by absorption and the microphone membrane is depressed. When the flow of infra-red rays is interrupted, the gas expands and the microphone membrane returns to normal. Pulsations of the microphone are amplified, the current is rectified and measured on a needle galvanometer. Deflexions of the galvanometer needle therefore correspond to the quantity of gas in the air of the experimental chamber. The connexion between the galvanometer readings and quantity of gas in the chamber can be determined experimentally by using known concentrations.

The optical-acoustic gas analyser can also sometimes be used to determine the presence of several different gases in the atmosphere, and also to measure the contents of mixtures of gases which do not contain air. The instrument is practically instantaneous in action and so sensitive that it will determine the presence of ether in a concentration of 0·1 milligram in a litre of air.

MARK VENGEROV

Moscow. May 16.
(By cable.)

Production of a Derivative of 5 : 6 Anhydroglucose by the Hydrolysis of an Ethereal Sulphate

ALTHOUGH it is now well established[1,2,3] that the alkaline hydrolysis of suitably substituted hexoses carrying sulphate groups on either the 3 or 6 positions readily yields 3 : 6 anhydrohexose derivatives, all our attempts to obtain evidence for the formation of ethylene oxide rings have been, until recently, unsuccessful, in marked contrast to the behaviour of the toluene-*p*-sulphonates[4]. It is now evident that this has been due largely to the fact that the barium salts of the sugar ethereal sulphates investigated were insoluble in organic solvents and the hydrolyses had, in consequence, to be carried out in aqueous media. Under such conditions experimental difficulties arise, for any ethylene oxide derivatives which may have been formed would be hydrolysed with accompanying Walden inversions[4]. Thus since the ethylene oxide ring formation would also involve a Walden inversion on the carbon atom where the sulphate group was originally attached, the production in recognizable quantity of a derivative of a hexose different from that in the original starting material depends on the relative ease of fission of the two ethylene oxide ring linkages. Thus the hydrolysis of a derivative of glucofuranose-3-sulphate could yield a 2 : 3 anhydroallofuranose, which might give either a gluco- or an altrofuranose derivative, or both[3].

This difficulty has now been overcome by the choice of barium 1 : 2-monoacetone-3-methyl-glucofuranose-6-sulphate as starting material. Treatment in methanolic solution with sodium methoxide at 40° for 3 hours yields 1 : 2-monoacetone-3-methyl-5 : 6 anhydroglucofuranose, the structure of which is proved by further treatment with sodium methoxide at 90° and hydrolysis to give crystalline 3 : 6-dimethylglucose ($[\alpha]_D^{18°}$ + 61° (equilibrium in water), m.p. 116°, not depressed by an authentic specimen kindly provided by Dr. D. J. Bell[5].

It is clear, therefore, that when conditions are suitable and the formation of a 3 : 6-anhydro ring is prevented by substitution, the hydrolysis of an ethereal sulphate readily gives rise to the production of an ethylene oxide ring, as in the case of the toluene-*p*-sulphonates. It is to be expected, therefore, that when the sulphate substituent is located on an asymmetric carbon atom with an adjacent hydroxyl group in the *trans* position, an ethylene oxide ring with accompanying Walden inversion will be produced on hydrolysis. Experiments are now in progress to test this hypothesis, which, if substantiated, will make it necessary to envisage the possibility of the interconversion of sugars in Nature through the intermediate formation of ethereal sulphates.

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Department of Chemistry,
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May 28.

[1] Percival and Soutar, *J. Chem Soc.*, 1475 (1940).
[2] Duff and Percival, *J. Chem. Soc.*, 830 (1941).
[3] Percival, *J. Chem. Soc.*, 119 (1945).
[4] Peat, *Ann. Rep. Chem. Soc.*, 260 (1939).
[5] Bell, *J. Chem. Soc.*, 1553 (1936).

Experimental Data and 'Sufficient' Accuracy

DURING a recent investigation on electron gun systems which involved the collection of numerical data—the measurements of a certain distance—the problem arose as to how many data it was necessary to collect in order to achieve sufficient accuracy in the final result, which, in this case, was ± 2 per cent. Use was made of the formula :

$$\alpha = 0{\cdot}6745 \sqrt{\frac{\Sigma (x_n - M)^2}{n(n-1)}},$$

where α is the most probable error of the arithmetic mean M, of a series of n observations x_1, x_2, etc.

A series of ten observations was made of the distance in question, on one system : the arithmetic mean of the observations 1 to n was calculated for each value of n, and hence α was determined for each of these sets. From the table of results it will be seen that α decreases with ascending values of n until the minimum value permitted by the experimental conditions is reached. Although it appeared that seven observations were sufficient to give the desired accuracy, it was decided to use ten in case greater experimental difficulty was encountered on other systems. This was justified when the values of $\alpha\sqrt{n}$, a measure of the 'fineness' of the observations, were found to vary slightly on the next ten systems, although, in every case, the most probable error of M was approximately the same as that required.

n	x_n	M	α
1	23·9	23·9	—
2	20·9	22·4	1·0
3	20·0	21·6	0·8
4	22·4	21·8	0·6
5	22·7	21·9	0·5
6	24·4	22·4	0·5
7	21·7	22·3	0·4
8	25·6	22·7	0·4
9	21·7	22·6	0·4
10	20·6	22·4	0·4

H. A. HUGHES

Standard Telephones and Cables, Ltd.,
Footscray, Kent.
May 8.

Gesture as a Constant Factor in Linguistics

IN May 1936, I wrote an article on KU in Chinese, which, through the courtesy of Prof. P. C. Chang, a Chinese philosopher then in London, was passed on to Prof. Y. R. Chao, the philologist, then in Nanking. The words and their meanings were taken from Karlgren's "Analytic Dictionary of Chinese and Sino-Japanese" (1923).

Of thirty-five words in KU- (or its variants, χU, KÜ, etc.), all except one were found to bear meanings which were simply connected with one or other of the natural gestural meanings of the mouth gesture.

I have heard from Prof. Alexander Johannesson that Prof. Chao (now in the United States) has written to him, referring to this article, and suggesting that the gesture theory may be "a constant factor for linguistic phenomena and not merely a theory to explain the history of words".

With this suggestion I would personally agree—in view of the comparative frequency of appropriate mouth gesture in children's invented words, in new words (such as 'blimp') or in new meanings for old words (such as 'slump').

R. A. S. PAGET

11 Cottesmore Gardens,
Kensington, W.8.
June 10.

Growth Curves

IN NATURE of January 19, 1946, there is a short communication by Prof. W. G. Burgers on "'Stimulation Crystals' and Twin-formation in Recrystallized Aluminium". As indicated in ref. 1 to this communication, the analysis of the forms of the grain boundaries was carried out by J. Sandee and appears in the Dutch journal *Physica* in 1942.

I should like to direct attention to the remarkable similarity between the curves analysed by Sandee and those discussed in a paper by me in the *Edinburgh Mathematical Notes* of December 1945 entitled "Curves Formed by Colonies of Micro-organisms Growing on a Plane Surface". My paper is a more detailed mathematical analysis arising out of work which I undertook at the University of Glasgow in connexion with a communication by Drs. G. Pontecorvo and A. R. Gemmell, entitled "Colonies of *Penicillium notatum* and other Moulds as Models for the Study of Population Genetics" and published in *Nature* of October 28, 1944.

The curves analysed in these two separate fields, of physical chemistry and the growth of living organisms, are identical. This rather remarkable fact may be of mutual help to workers in both fields, while at the same time it offers scope for some interesting philosophical deductions.

AGNES H. WADDELL

c/o J. Rössler,
Bredovska 15, Prague II.
May 16.

Postal Communication with the U.S.S.R.

IN September 1945 I had the privilege, as president of the Genetical Society, of inviting four distinguished Russian geneticists to a conference in London, to take place on October 31. I received a reply from one of them in February of this year, and on May 30 a reply from another which runs as follows :

Moscow, May 3, 1946.

Dear Dr. Darlington,

I am very grateful to you for your invitation to the Conference of the Genetical Society dated September 19th, 1945. Unfortunately, it reached me on the 27th of [April] 1946, so that I couldn't possibly avail myself of the opportunity. I do not lose hope of meeting you in the near future at the next session of your Society.

Very sincerely yours,
(Sgn.) N. P. Dubinin.

The letter bore the air mail post-mark of May 19, my letter having evidently been received on April 27 and replied to six days later. I have received no reply from the other two invited guests.

Since I find communication with my Russian colleagues so difficult, especially with my old friends Lewitzky and Karpechenko, may I be permitted to make use of these columns to say how much I, and my colleagues in Great Britain, look forward to the renewal of our scientific intercourse ?

C. D. DARLINGTON

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RESEARCH ITEMS

Breeding of the Rock-Dove

FOLLOWING his finding of rock-doves (*Columba l. livia*) in full nesting activity in January 1944, at Eathie Shore by Cromarty, John Lees has made further observations in the same caves, which show that breeding activity goes on more or less all the year round (*British Birds*, **34**, No. 5, May 1946). There is a marked maximum in April, coinciding with the general nesting season for resident birds. The minimum occurs in July, and this may be coincident with the moulting of the body feathers; moulting certainly proceeds during the autumn months. Periods of nesting alternate with periods of quiescence, the latter being usually quite short and sometimes non-existent through the interlapping of active periods. The active periods fall into four groups. There is the main period of spring nesting, where hatching takes place about April. This is followed, after a break, by a summer activity, young birds appearing in August. After this come autumn and winter periods, with hatchings about November and January.

Classification of Dermestid Beetles

MISCELLANEOUS PUBLICATION No. 511 of the United States Department of Agriculture is of general interest to entomologists. It deals with the classification, based upon larval characters, of beetles of the family Dermestidæ, and is written by Bryant E. Rees, of the Division of Insect Identification, U.S. Bureau of Entomology and Plant Quarantine. Included in this family are the larder, hide and carpet beetles, all of which are highly injurious to the activities and interests of man. In their larval stages these insects feed upon, damage or destroy a wide range of goods, especially those made of, or containing, leather, hair, fur, wool or silk, besides museum specimens and numerous stored products such as bacon, cheese, seeds, grain, cork, etc. In war-time, many kinds of military stores have to be protected against their attacks. The adult beetles, however, are not directly injurious to any great extent. In order to control the damage caused by Dermestidæ, a knowledge of their larvæ is, therefore, of prime importance. While numerous scattered and usually inadequate descriptions exist, no general work on the subject had been undertaken. The present pamphlet will, it is believed, prove a useful aid to the identification of the various genera, and economic entomologists especially will welcome its appearance. It is interesting to note that a study of the larvæ of species of *Entomotrogus*, *Eucnocerus* and of several species of *Trigoderma* revealed no characters by which the three genera could be separated; they agree in all constant characters, and it is suggested the species may all be congeneric.

Bacteriostatic Substances in Fungi

W. H. Wilkins and G. C. M. Harris are continuing their examination of various fungi for the production of bacteriostatic substances (*Trans. Brit. Mycol. Soc.*, **27**, 113; 1945). This third group of a hundred species and strains of *Aspergillus* shows quite a good measure of bacteriostatic activity against three representative types of bacteria—*Staphylococcus aureus*, *Bacterium coli* and *Pseudomonas pyocyanea*. It becomes increasingly clear, however, that every isolation should be treated as "an individual fungus whose physiological potentialities are probably quite distinct from other isolations and strains of the same fungus". The production of bacteriostatic substances varies with different media. Malt, potato dextrose and modified Czapek-Dox agar have been found most generally suitable, but it seems possible that optimal media could be made to suit particular fungi.

Genetics of Blight-Resistant Potatoes

SEVERAL potato seedlings resistant to blight, *Phytophthora infestans*, have been produced by the Scottish Plant Breeding Station, Corstorphine, Edinburgh. William Black has recently analysed the genetics of these productions (*Proc. Roy. Soc. Edin.*, B, 62, Pt. 2, No. 20; 1945), which apparently owe their resistance to the 'wild' ancestor, *Solanum demissum*. Derivatives of the triple hybrid (*S. Rybinii* × *S. demissum*) × *S. tuberosum*, and of a multiple species hybrid involving *S. commersonii*, *S. maglia*, *S. edinense*, *S. demissum* and *S. tuberosum* have been tested for their reaction to strains 'A' and 'B' of the blight fungus. The evidence indicates that resistance to blight is controlled by major genes, though minor genes determine the degree of susceptibility in susceptible varieties. Consistent excesses of recessive individuals over the expected standard ratios were found in the segregation of resistant and susceptible plants. This may be due in part to chromosome homologies leading to multivalent-formation and double reduction. In the material studied, however, the deviation in favour of recessives diminishes in consecutive generations. This is interpreted as a lowering of residual incompatibility factors derived from the original 'wild' material, and should augur well for the practical usefulness of subsequent generations.

Marsh Spot Disease of Peas

SOME disorders of plants require the joint ministrations of pathologist and chemist for diagnosis and control. Marsh spot of peas, where dark-brown lesions appear on the flat sides of the cotyledons, is not caused by any parasite; it is a symptom of manganese deficiency. Thomas Walsh and Stephen J. Cullinan (*Proc. Roy. Irish Acad.*, **50**, B, No. 15, 279, June 1945) have shown that the varieties Laxton's Superb and Blues were unaffected, Marrowfat and Alderman had moderate attacks, while Onward and Giant Stride showed severe lesions. Application of 56 lb. of manganese sulphate an acre reduced the malady somewhat, but spraying the foliage with 1 per cent manganese sulphate solution at flowering time resulted in complete control.

Rust of Cultivated Roses

OF nine rusts recorded on species of *Rosa* in the United States only *Phragmidium mucronatum* is of economic importance, and this is virtually restricted to the western seaboard. A detailed study by V. W. Cochrane (*Cornell Univ. Agric. Exp. Sta.*, Mem. 268; 1945) shows that the uredospores are relatively short-lived and are killed by extremes of temperature. In California the mild climate enables uredospores to persist all the year and to maintain a high level of infection, whereas in the eastern United States, spring infection is entirely from teleutopores, and uredospore formation is checked by the heat of summer. Host-parasite relations and conditions of spore germination and development are fully tabulated.

Currents of the Bosporus

IN a paper on the hydrography of the Bosporus published in the *Geographical Review* of January 1946,

P. Ullyott and O. Ilgaz bring forward new facts on bathymetry and current flow confuting the old idea of a simple surface flow southward from the Black Sea and a bottom flow northward to the Black Sea. New facts regarding submarine relief show a threshold at the Black Sea end of the Bosporus against which ends the deep canal of the strait. This fact, and that of the low salinity of the deep waters of the Black Sea, will not conform to the usually accepted theory. The authors agree that currents in the Sea of Marmora and Bosporus are as generally accepted, but that the northward flow in the deep canal, on account of the shallow threshold, never reaches the Black Sea, but is turned back and incorporated in the southward setting surface current. Thus the Black Sea does not receive any water through the straits, and a balance is effected by gain through drainage supply, loss by evaporation and outflow by surface current into the Ægean Sea. This balance sheet of gain and loss, if true, would account for the low salinity of the deeper waters of the Black Sea.

Porosity of Rocks and Geospheres

G. A. Maximovich (*Bull. Acad. Sci. URSS, Sér. giograph. géophys.*, **8**, 298; 1944), after making a compilation of several thousands of determination of rock-porosity, including numerous unpublished data from Russian sources, has calculated the average porosities of different types of rocks and has also calculated the average porosities of the geospheres. These, in percentages, are as follows: pedosphere (soils), 55; pelosphere (oozes, etc.), 50; hypopedosphere (subsoils, etc.), 40; stratisphere (sedimentary rocks), 25; metamorphosphere (metamorphic rocks), 2½; granitosphere (acid igneous rocks), 1; basaltosphere (basic igneous rocks), less than 1. These calculations allowed him to calculate the average degree of compaction for various rocks and to draw some conclusions which may be of interest to oil- and water-geologists, geophysicists and geochemists.

Surface Tension of Mercury

The surface tension of mercury has been the subject of many investigations under very different conditions and by many different methods; but measurements are in nearly all cases confined to temperatures above 0° C. Bircumshaw, in 1931, was, according to his own statement, the first to measure the surface tension within the region 0° C. and the freezing point −38·6° C. He used the maximum bubble pressure method and found that at the lower temperatures the relationship between the surface tension and the temperature was not linear and that there was some evidence that mercury has a positive temperature coefficient of surface tension just above the freezing point. Since Bircumshaw's work it would appear that the only determination of the surface tension below 0° C. is that of S. Mussa and B. Takla at the Fouad I University in Cairo. A report of their work has just recently reached Britain (*Bull. Fac. Sci.*, No. 24, 1; 1941). They determined the surface tension at approximately 5° C. intervals over the range 67° C. to −20° C. using the large-drop method as modified by A. E. Bate. The surface tension increases linearly from 67° C. to −5° C., but as the temperature is still further reduced the surface tension decreases considerably and there is a marked deviation from a linear relation. The shape of the curve resembles somewhat that obtained by Bircumshaw. No explanation is given for the fall in the surface tension; but it is asserted that it can scarcely be due to experimental error or to impurity in the surface of the mercury. The mercury used was purified and doubly distilled and the surface tension measured *in vacuo*.

Phosphorylation

Esters and amides of phosphoric acid play an important part in many biological processes, but their laboratory synthesis is still a matter of difficulty. In work on purine glycosides, a convenient method for the phosphorylation of alcohols, in particular carbohydrates, and amines is necessary. F. R. Atherton, H. T. Openshaw and A. R. Todd (*J. Chem. Soc.*, 382; 1945) give a review of known phosphorylation procedures and describe experiments on the use of dibenzyl chlorophosphonate, $(CH_2Ph.O)_2POCl$, as a reagent. It cannot be distilled but can be used in carbon tetrachloride solution. It readily reacts with amines to form dibenzyl aminophosphonates, and with alcohols in presence of pyridine and with sodium salts of phenols, to give dibenzyl phosphoric esters. The benzyl groups in these products can be removed by hydrogenolysis. H. McCombie, B. C. Saunders and G. J. Stacey (*J. Chem. Soc.*, 380; 1945) also describe the preparation of some esters containing phosphorus. Dialkyl chlorophosphonates (dialkylphosphoryl chlorides) are formed by the reaction of a dialkyl hydrogen phosphite with chlorine in the cold; the dialkyl chlorophosphonate, obtained in high yield, is readily identified by the formation of crystalline aminophosphonates with amines. Other methods of preparation are described.

General Magnetic Field of the Sun

T. G. Cowling (*Mon. Not. Roy. Astro. Soc.*, **105**, 3; 1945) has reviewed some previous theories to explain the sun's electric field, and he points out that all are inadequate. A first investigation by the author shows that the time of decay of the sun's magnetic field, assuming that it decays only as a result of electromagnetic effects, is about 5×10^9 years, and as this seems a long time, the matter is investigated in more detail. As a result of this investigation, Cowling finds that the period is about 10^{10} years, which is of the order of the time-scale of the expanding universe, and the magnetic field may be a relic from a different primeval state. The assumption that the sun's magnetic field is explained by some unassigned cause operative so long ago is a confession of ignorance, for which reason Cowling examines an alternative hypothesis, that the sun's general field may be due to thermal effects in a rotating mass—a view advanced by W. M. Elasser in 1939 to explain the earth's magnetic field. On developing this theory it is found that the results, while giving a field of the correct sign, give less than 10^{-7} of the observed field. The question arises whether the small field due to thermal currents may not be magnified by dynamo action, due to the circulation of material in meridian planes. This hypothesis, however, must be rejected, because it would require a time equal to $1{\cdot}6 \times 10^{18}$ years to produce the present field in the sun. Other possible explanations are briefly considered, including the view that the material in the far interior of the sun is capable of permanent magnetization; and although it requires that a very hot and ionized material is capable of acquiring a regular, crystal-like structure—a possibility usually disregarded—nevertheless Cowling thinks that it is worthy of further investigation, in view of the difficulties of other hypotheses.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, NEW ZEALAND

ANNUAL REPORT

THE nineteenth annual report of the Department of Scientific and Industrial Research, New Zealand (Wellington: Government Printer. 1*s.* 6*d.*), covers the year 1944–45, and includes the Minister's statement, the secretary's report and reports of the Research Committees of the Council as well as of the Cawthron Institute, the work of the Dominion Laboratory, Observatory and Physical Laboratory, the Geological Survey and Magnetic Observatory, the Meteorological Branch and research work at Canterbury and Massey Agricultural Colleges.

Research during the year under the Building Research Committee embraced the study, and methods of control, of timber-infesting insects and fungi, carried out by the Plant Diseases Division, the Entomology Division and State Advances Corporation; the causation and control of mould infestation in houses; investigations of a system of prefabrication in standard concrete and light-weight (pumice) concrete and a review of literature on the acoustics of building, preparatory to carrying out experimental work with particular reference to multiwall units. The Committee also considered a report by the New Zealand Institute of Architects on proposals for earthquake reconstruction in earthquake danger zones, and recommended a national survey of all buildings to determine their structural stability under earthquake stress.

The Dairy Research Institute continued its work in collaboration with the Entomology Division of the Plant Research Bureau on the control of cheese-mite; trials with dichloroethyl ether have shown great promise as a means of control in curing rooms. Isolated starter-rooms and other devices designed to exclude airborne bacteriophage infection of starter culture for cheese manufacture continued to give success in the maintenance of cultures. Trouble due to failure of acid development in the cheese vat still occurs due to infection of the factory equipment and infection of the milk delivered from cans which have been used for the transport of whey. The former infection is easily checked by chlorinating the vats, pasteurizer and piping, but the contamination of the milk cans is much more difficult to eliminate. Chlorination of the whey proved practicable but costly. Other investigations covered the effect of the feeding of cows on the characteristics of cheese, milk, dairy cow nutrition and growth-hormone studies, and the value of various irrigants in the treatment of mastitis.

The Food Preservation and Transport Advisory Committee's investigation on the refrigerated gas storage of apples, superficial scald on Granny Smiths, the influence of rootstock and intermediate scion on core-flush in Granny Smiths and the effect of fertilizers on the cold-storage quality of apples were taken a stage further. Fruit research included long-term manurial investigations, small-scale trials of D.D.T. and other insecticides for control of carrot aphids, red-mite, codling moth, etc.

A Manufacturer's Research Committee was established to survey the present state of New Zealand manufacturing industry in the light of modern scientific developments, to consider plans for concerted efforts to meet the demands of the post-war period, as well as methods for the application of science in development, extension and modernization of existing industries and to encourage the formation of research associations in appropriate industries, the employment of technical assistance in industry and the investigation of particular industrial problems by the Department of Scientific and Industrial Research or other scientific institutions.

In the Plant Chemistry Laboratory the preservation of food by dehydration received most attention, vegetables and apples being the subject of most of the work, though some work was carried out on stone-fruits and with pears. Work continued at the Plant Research Bureau on linen flax, and in the Botany Division on seaweed resources and weed investigations. Plant disease investigations by the Plant Diseases Division covered the bacterial wilt of beans, carrot rust-fly and tests of inert dust to protect stored grain from weevil attack, as well as preliminary work on the production of penicillin. The Wheat Research Institute evolved a new wheat strain, equal in yield to Cross 7 but with a considerably higher baking score and protein content, while milling practice was improved so as to ensure higher food value being secured from the flour produced. Tobacco research resulted in a considerable measure of control being secured in the field over mosaic disease, and showed that high-quality seed can be produced locally, rendering New Zealand independent in this respect.

An important experiment in North Auckland in evaluating the soil maps in relation to the factors concerned in economic management, production and potential land use showed that the soil survey has enormous potentialities. At the Cawthron Institute, in addition to soil survey work, tomato investigations included the use of steam and formaldehyde for treating glasshouse soil and tests of soil disinfectants on outside tomato soil. At the Canterbury Agricultural College the effect of fertilizer treatment on the production of subterranean clover continued. Entomological investigations there included sheep-dipping trials, trials for the control of stem weevil and Hessian fly on wheat. At the Massey Agricultural College sheep nutrition experiments have continued both as research into animal nutrition and on the parasitology of sheep.

As a result of discussions on the functions of the Dominion Physical Laboratory, it has been recommended that the post-war function of this Laboratory should be such that its decision on physical matters of precision, quality and performance be accepted as final; its functions are more specifically stated as general research and development of a physical and engineering nature; calibration and repair and general testing of civil, mechanical and electrical equipment; work for the New Zealand Standards Institution and general physical testing of goods and commodities and the custody and control of the legal physical standards of measurement. A feature of the year's work was the increasing number of requests for assistance made to the Laboratory by industry.

RADIO FREQUENCY MEASURING TECHNIQUE

RECENT issues of the *Proceedings* of the Radio Section of the Institution of Electrical Engineers, forming Part III of the *Journal* of the Institution, contain several papers describing advances in the technique of measuring various electrical quantities at increasingly higher radio frequencies. Another series of papers was read at the Radiolocation Convention held by the Institution; and the publication of these in the near future will be awaited with interest.

The measurement of frequency itself in the range 300-10,000 Mc./s. is dealt with in a paper by Dr. L. Essen and Mr. A. C. Gordon-Smith published in the December issue of the *Proceedings*. This paper is an official communication from the National Physical Laboratory and describes how the usual heterodyne methods of measuring a frequency by comparison with an appropriate harmonic of a standard quartz oscillator can be extended to the highest frequencies now in general use. A self-contained portable apparatus is described, incorporating both a quartz-controlled oscillator and two interpolating oscillators, the whole set, excluding the power supply equipment, weighing about 30 lb. A measurement of an unknown frequency can be made in a few seconds, so that the frequency drift of the interpolating oscillators is very small. The accuracy of measurement in terms of the frequency of the quartz oscillator is $\pm$ 1 part in 10^6; but for an overall accuracy of this order, it is usually necessary to check the frequency of the quartz oscillator.

Another paper in the December issue of the *Proceedings*, by Mr. R. F. Proctor and Dr. E. G. James, describes a radio-frequency capacitance and conductance bridge which operates at a frequency of 1 Mc./s. This bridge is suitable for the measurement of capacitances from 0 to 28 $\mu\mu$F, and parallel conductances from 0 to 11 micromhos (90,000 ohms). One side of both the generator and the detector is earthed, and the bridge has the great advantage that the capacitance between earth and each electrode of the partial capacitance being measured does not affect the balance condition. The design of the bridge lends itself to operation at frequencies up to 50 Mc./s., provided that the usual precautions are taken with regard to residual capacitances and inductances.

The numerous war-time applications of centimetric waves gave rise to the need for developing new techniques for measuring the properties of dielectric materials at extremely high frequencies, with particular reference to low-loss materials such as polythene and polystyrene. At frequencies above 100 Mc./s., lumped resonant circuits become increasingly difficult to devise and operate, and they are consequently replaced by resonant elements of either transmission lines or wave guides. The theory and experimental development of such techniques suitable for frequencies of more than 600 Mc./s. (wave-lengths less than 50 cm.) are described in a paper entitled "Resonance Methods of Dielectric Measurement at Centimetre Wavelengths", by Messrs. F. Horner, T. A. Taylor, R. Dunsmuir, J. Lamb and Prof. Willis Jackson, and published in the January issue of the *Proceedings*. The relative suitability of three forms of resonator, one a short-circuited length of coaxial transmission line, and the other two cavity-resonators operating in different modes, is discussed. It is shown that for dielectric measurements, complete filling of the resonators with dielectric is unnecessary, a conclusion which has considerably facilitated the experimental work on solid dielectrics. The paper contains a description of apparatus used for measurements at frequencies of about 3,000 Mc./s. (wave-length 10 cm.) and a statement of typical experimental results obtained with a specimen of polythene, which at the above frequency had a permittivity of 2·27 and a power factor of 0·0004. The accuracy attainable in such measurements is discussed in the paper.

The March issue of the *Proceedings* contains a paper entitled "Radio Measurements in the Decimetre and Centimetre Wavebands", by Mr. R. J. Clayton, Drs. J. E. Houldin and H. R. L. Lamont, and Mr. W. E. Willshaw; and this describes a wide field of radio-frequency measuring technique as it evolved in the Research Laboratories of the General Electric Co., Ltd. Such a technique was a necessary aid to the development of valves, circuits and equipment required during the War for increasingly higher frequencies; and the paper begins with a review of the circuit theory of coaxial and wave-guide transmission lines, followed by a short discussion of high-frequency oscillators. Succeeding portions of the paper deal with the measurement of the fundamental quantities of frequency, power, impedance, voltage and current. The concluding sections of the paper are concerned with measurements derived from the above quantities; such as receiver sensitivity, aerial gain and impedance, and radio field-strength. Descriptions are given of some of the practical equipments developed for these measurements; and the discussion which took place at the reading of the paper before the Radio Section of the Institution, brought to light some information on similar work which has been in progress elsewhere in Britain during the war years.

CIVIL ENGINEERING AS A CAREER

THE Institution of Civil Engineers has given a fine lead to other professions in its recently published brochure entitled "Civil Engineering as a Career". With the ever-increasing width of human activity, the percentage of young men who can have anything but an elementary idea of the kind of life to which their chosen job is going to lead them must be small, and here in compact but fully informative form is an admirably drawn picture of a profession, rightly encouraging, but without any trace of propaganda. It merits the most careful study by anyone whose responsibilities entail advising scientifically inclined young men what lies open to them. It should certainly be in the hands of every young engineer in his early days at the university, when he is faced with the choice of what branch of the profession he is going to adopt.

The excellence of this publication must not blind one, however, to a serious disadvantage from which civil engineering seems to suffer, and which is somewhat of a high price to pay for the undoubted interest and satisfaction to be found in this branch of the profession. This disadvantage is the lack of security, not in earlier years, of course, when a young man's thoughts should be turned towards fitting himself for the high responsibilities ahead, but later on when most men have home responsibilities. Civil engineering is a profession of high adventure, but high adventure normally signifies high reward for those

with the courage and spirit to see it through, and it is very doubtful if such reward falls to the lot of the reasonably successful civil engineer.

Civil engineering is, if we may use the mathematical analogy, the second differential of the profession, the aim of which is the acceleration of normal progress; and in the earlier years of this century when everything was alive with expansion, there was no doubt in the truth of the statement that a civil engineer could walk the length of Victoria Street, London, and find himself with a dozen excellent assignments to choose from. Those good days are, however, past, and we live in more sober times, added to which the 'dynamic' side of engineering has made immense strides both in the width of its products and in their application to industry. What could offer higher adventure than the development of the jet engine, or radar; or the smooth and effective running of a complicated human machine such as a works of some thousands of hands, with all the problems of production control and the enjoyment of the command of men: and with all this, more security of tenure and, we think, very appreciably greater financial reward? Higher executives in engineering firms or industry can look to salaries of £1,000–£1,500 or more from about the age of thirty-five onwards, a level which we doubt can be expected by a resident civil engineer of comparable age, technical training and experience.

This, then, is the competition which civil engineering has to face. The insecurity, save for the fortunate few who may perhaps become partners in a firm of repute, seems inevitable. Manufacturing industry is a continuous process, slow or fast maybe, but in steady motion, whereas big public works are dependent for their life on a wide variety of circumstances and are the first to be hit by any period of depression. May it be hoped, therefore, that to attract to this branch of the profession the best young men, as it well deserves, the rewards will be very real. Consultants' expenses are high, but surely on a contract totalling some hundreds of thousands of pounds a rise in the price of that essential raw material, namely, the resident engineer's skill and devotion, would scarcely make an appreciable difference.

Certain branches of civil engineering are of the 'service' type, with a planned career, but we are not sure even here whether the terms offered are fairly aligned with those in other careers of a similar nature. It might not be unwarranted to draw an analogy between such careers and the financial world, where the yield of government securities largely regulates the gilt-edged market. This analogy is pointed by the terms recently offered by the Government Scientific Service, designed to attract the best material of Britain to a career which cannot offer more than a fair reward compatible with security and pension. It would be extremely interesting to compare these with the prospects ahead of a young engineer in, say, one of the railways.

Civil engineering suffers from a further disadvantage at the other end of the scale, namely, the conditions of entry. Criticism on this count is now, to some extent, disarmed by the reference on page 12 of the brochure to recent arrangements made between the Institution of Civil Engineers and both the Institution of Municipal and County Engineers and the Federation of Civil Engineering Contractors, for the proper training of young engineers entering the profession through these two latter channels. We understand, although it is not mentioned, that the scheme envisages a salary of the order of £250–£300 a year for a two-year indenture. This is a most excellent move on which the Institution of Civil Engineering is to be congratulated, the level being approximately the same as that now offered by the big 'training' firms in the electrical and mechanical world. Contracting and municipal engineering are, however, only branches of civil engineering so to speak, and it is a matter of some regret that the lead in improved conditions for training has not been given by the 'core' of the profession, namely, the consultants. The chapter on consulting engineering includes only a somewhat vague and unsatisfactory reference to the proper method of entry, together with an ominous, and surely unnecessary, warning of the perils of aiming at too high a salary in early years. The young engineer of to-day is a young man with a very realistic view of life and a readiness to learn his craft thoroughly—provided it does not entail his being a burden on his heavily taxed parents.

BOMBYLIIDÆ OR BEE FLIES OF EGYPT

THE Bombyliidæ or bee flies are very well represented in a warm, sunny country like Egypt. They are an exceptionally interesting group of Diptera to the entomologist, not only on account of the remarkable range of form displayed by the adult flies but also owing to the curious parasitic habits of their larvæ. Prof. Efflatoun Bey has recently made a very detailed study of the Egyptian species*, and the results of his labours form Part VI of his well-known "Monograph of Egyptian Diptera".

The Bombyliidæ are poorly represented in cold or cool countries, but they rapidly increase in number of species as we pass southwards. Thus, the author mentions that while there are only nine British species and fourteen Danish forms, some sixty kinds are recorded by Schiner from Austria and 115 from Spain. In 1924, 594 species were known from the Ethiopian region, and that number is only a small proportion of those that probably remain still to be discovered. In 1919, fewer than fifty species of bee flies were known from Egypt, but to-day that number is more than quadrupled. For reasons of economy and convenience, the results of Prof. Efflatoun's study are to appear in two parts. The present, on Section I, deals with the Bombyliidæ Homœophthalmæ or those in which the compound eyes are simple, that is, not indented on the hind margin. Section II, dealing with the Bombyliidæ Tomophthalmæ, or those in which the eyes are evidently indented, will, it is hoped, be published in the near future. A series of beautiful coloured plates have characterized the previous parts of this monograph, and their absence from the present section immediately attracts notice. Prof. Efflatoun mentions that they cannot be published at present owing to difficulties arising out of the War, but it is expected that they will be issued later. On the other hand, the work is very well illustrated by some 38 black-and-white plates comprising more than 550 well-drawn figures of structural details pertaining to the different species.

At the present time nothing is known concerning the early stages of these flies in Egypt, and here a wide field of inquiry awaits a competent investigator.

* A Monograph of Egyptian Diptera. Part VI. Family Bombyliidæ. Section I. By Prof. H. C. Efflatoun Bey. *Bull. Soc. Fouad 1er d'Entomologie*, pp. 482+38 pl., 1945.

Elsewhere it is known that a number of species attack one or other kind of migratory locust in the egg stage. Other Bombyliidæ parasitize the caterpillars of moths or the larvæ of solitary bees and fossorial wasps. Fabre, for example, gave an interesting account of a species that lives at the expense of the mason bee. One species has been bred from the puparia of tsetse flies (*Glossina*) and others are hyperparasites.

In Prof. Efflatoun's opinion the systematic arrangement of the Bombyliidæ still awaits a competent monographer, notwithstanding the labours of such authorities as Becker and Bezzi. The limits of some of the subfamilies are by no means well defined and the allocation of various genera is open to doubt. Possibly, as Bezzi originally suggested, a closer knowledge of the bionomics and ethnology of the family will lead to a better taxonomy. The Bombyliid fauna of Egypt, as with many other families, undoubtedly forms, according to Prof. Efflatoun, a connecting link with the Palæarctic and Ethiopian zoogeographical regions. A. D. Imms

RECONSTRUCTION IN THE ASSAM HILLS

THE process of reconstruction must vary in different localities, but in most cases the anthropologist can be of real assistance. In his presidential address for 1945 to the Royal Anthropological Institute of Great Britain and Ireland, Prof. J. H. Hutton discussed some problems of reconstruction as they will appear in the Assam Hills. Any hill-tribe tends to lead a more or less segregated life, and until this century the Nagas had had only sporadic communication with the outside world. The First World War was responsible for a certain amount of contact, but it was not until the recent campaign in their country that any large-scale opening-up occurred. Now there are good roads, and communication by air is also established.

Communications, with the labour necessary to maintain them, will mean a steady flow of money, in the form of wages, into the country; and with the further opening-up of Burma and Assam, the Nagas will inevitably have to relinquish their position of isolation. Indeed, one curious result of the Japanese invasion was that it gave the Nagas a feeling of partnership with the other peoples who were fighting the common foe, and proved them most loyal and helpful to the Allies.

In return for this, it behoves us to see that the changes that have been wrought so suddenly should be beneficial and not detrimental to this fine race. They have an intense love of independence. They are asking for education; but it must be the right sort and benefit the whole community, rather than create a class of minor clerks who will try to exploit the less bookish members.

Another problem concerns the administration of the district: to what degree the Nagas are capable of indirect rule, and how far collective responsibility may be a workable proposition. Then, too, there is the language question, for example, whether the higher education should be given in English or Assamese; and if the latter, which of the several dialects should be used and reduced to writing. Cultivation of the hill country is another important question: removal of the forests reduces the rainfall necessary for the irrigation of the terraces which have replaced the tree-covered slopes, thus setting up a vicious circle from which there seems no escape since rice is a staple food.

These, then, are some of the problems of this area, a comparatively small one, and similar problems on a larger scale await solution in practically all south-east Asia, Indonesia and Oceania. The need for applied anthropology is unquestionable. Changes there are, and must increasingly be, and it is the duty of those responsible for administration to see that the welfare of indigenous peoples is the first consideration. K. R.

LAMARCK BICENTENARY CELEBRATIONS

CELEBRATIONS in honour of the bicentenary of the birth of Lamarck were held in Paris during June 15–18, under the auspices of the Muséum National d'Histoire Naturelle, the Société Zoologique de France and the Société Botanique de France. A number of foreign guests were invited, and included representatives from Belgium, Denmark, Great Britain, Holland, Mexico, Portugal and Switzerland.

The proceedings started on June 15 by an inaugural session in the great amphitheatre of the Museum under the chairmanship of the Ministre de l'Education Nationale. The chief events in the life of Lamarck were traced by M. A. Urbain, director of the Museum; M. H. Humbert spoke of Lamarck's contributions to botany, and M. R. Jeannel of his services to zoology; Prof. M. Caullery reviewed the significance of Lamarck's work from the point of evolution, and assessed the position which it occupies to-day.

The morning of June 16 was devoted to a demonstration of exhibits relating to the life of Lamarck; a charming and interesting feature of the occasion was the presence of representatives of Lamarck's family, in the persons of his great-great-grandsons. A wreath was laid at the foot of Lamarck's statue, and the delegates then attended a banquet presided over by the Directeur des Rélations Culturelles of the Ministère des Affaires Étrangères. In the afternoon the delegates were taken over the Musée de l'Homme by its founder and director, M. Rivet.

On June 17, the delegates were taken to the Zoological Park at Vincennes, where they had the opportunity of seeing many interesting animals and of learning of the difficulties encountered—and largely surmounted—in obtaining food for them. After enjoying the wonderful view from the top of the Grand Rocher, the delegates were entertained to luncheon by their hosts under the chairmanship of the Directeur de L'Enseignement Supérieur of the Ministère de L'Education Nationale. After returning to Paris the delegates attended a reception at the Laboratoire d'Evolution des Etre Organisés.

From this point, the programme was divided, and the delegates attended meetings of the Société Zoologique and of the Société Botanique, respectively, including demonstrations and communications.

The proceedings were marked by the greatest cordiality, and the trouble taken by the organisers in the face of considerable difficulties as regards food and accommodation was deeply appreciated by the visitors, who were very grateful for the opportunity to renew old friendships and make new ones while paying tribute to the name of Lamarck.

FORTHCOMING EVENTS

Monday, July 8

BRITISH ASSOCIATION (joint meeting with the ROYAL SOCIETY EMPIRE CONFERENCE, at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Conference on "Dissemination of Scientific Information to the Public".

Thursday, July 11

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. C. N. Hinshelwood, F.R.S.: "The More Recent Work on the Hydrogen-Oxygen Reaction" (Bakerian Lecture).

Tuesday, July 9—Thursday, July 11

INSTITUTE OF PHYSICS, X-RAY ANALYSIS GROUP (at the Royal Institution, 21 Albemarle Street, London, W.1), at 10 a.m. each day.—Conference on "X-Ray Analysis during the War Years".

Tuesday, July 9—Saturday, July 13

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at Tunbridge Wells).—Jubilee Congress.

Tuesday, July 9, at 8.15 p.m. (at the Council Chamber, Town Hall).—Prof. J. D. Bernal, F.R.S.: "The Place of Scientific Societies in the New World" (Presidential Address).

Thursday, July 11—Saturday, July 13

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the Physics Department, The University, Oxford Road, Manchester 13).—Conference on "The Measurement of Stress and Strain in Solids".
(Thursday, at 2 p.m.; Friday, at 9.30 a.m.; Saturday, at 9.30 a.m.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHYSIOLOGY AND ZOOLOGY—The Registrar, Technical College, Sunderland (July 13).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT, a LECTURER IN THE MATHEMATICS DEPARTMENT, and a LECTURER IN THE NATURAL PHILOSOPHY DEPARTMENT—The Secretary, Royal Technical College, Glasgow (July 13).

LECTURER IN MATHEMATICS, PHYSICS AND CHEMISTRY for National Certificates, Matriculation and Intermediate Science courses, at the Oxford School of Technology—The Chief Education Officer, 77 George Street, Oxford (July 13).

LECTURER IN PHYSICS AND MATHEMATICS at the Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick (July 13).

LECTURER and an ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, University College, Gower Street, London, W.C.1 (July 15).

LECTURER IN ELECTRICAL MACHINERY AND DESIGN—The Registrar, College of Technology, Manchester 1 (July 15).

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS, preferably with qualifications in Pure Mathematics—The Registrar, University College, Hull (July 16).

HEAD OF THE DEPARTMENT OF HORTICULTURE, and an ASSISTANT LECTURER IN AGRICULTURE, at the Yorkshire Institute of Agriculture, Askham Bryan—The Joint Clerk, Yorkshire Council for Agricultural Education, County Hall, Beverley, Yorks. (July 17).

LECTURER and an ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Head of the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S.W.7 (July 17).

PROFESSOR OF CHEMICAL TECHNOLOGY, an ASSISTANT PROFESSOR OF PRODUCTION METALLURGY, LECTURERS (4) on PHYSICAL METALLURGY, ELECTRO-METALLURGY, FUELS, and MINERALOGICAL CHEMISTRY, an ASSISTANT PROFESSOR and a LECTURER IN THE DEPARTMENT OF INTERNAL COMBUSTION ENGINEERING, an ASSISTANT PROFESSOR and a LECTURER IN HIGH VOLTAGE ENGINEERING, at the Indian Institute of Science, Bangalore—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (July 20).

STATISTICIAN for the Agricultural Development Scheme, Nigeria (candidates must have an Honours Degree in any of the Natural Sciences or Agriculture, and post-graduate training in Agriculture or similar statistics as applied to research)—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting Order No. G.209/AO (July 20).

ASSISTANT LECTURER AND DEMONSTRATOR IN CHEMISTRY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (July 20).

LECTURER IN PSYCHOLOGY—The Registrar, The University, Manchester 13 (July 22).

CHIEF OF THE DIVISION OF TEXTILE RESEARCH, Council for Scientific and Industrial Research—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (July 27).

ASSISTANT RESEARCH ENGINEERS (3, Honours University degree essential, with preferably post-graduate training and some experience in Chemical Engineering, Steam Boiler Plant, Gas Dynamics, or Electrical Machinery)—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting Plant Engineering Division (July 31).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Sheffield (July 31).

STATISTICIAN to assist in the application of statistical methods to the problems of Horticultural Field and Laboratory experiments—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (August 1).

ARTIST (whole-time) IN THE ANATOMY DEPARTMENT to undertake drawings from whole specimens and microscope slides, and the preparation of diagrams—The Secretary, University College, Gower Street, London, W.C.1 (August 1).

CURATOR OF THE ANATOMY MUSEUM—The Secretary, University College, Gower Street, London, W.C.1 (August 1).

BASHFORTH PROFESSOR OF MATHEMATICAL PHYSICS at the Military College of Science—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, endorsed 'M.C.S.', and quoting No. 1517 (August 19).

ENTOMOLOGISTS (2) for the Research Division, Department of Agriculture and Forests, Sudan (for investigation of and control measures against crop pests including locusts)—The Sudan Agent, London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist'.

ORGANIC CHEMIST (with Ph.D. Degree or equivalent) for work in the Development Department at Welwyn Garden City—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

PRINCIPAL of a new Institute of Jute Technology to be established in Calcutta for the scientific and technical training of Indian mill personnel—The Secretary, Indian Jute Mills Association, Research Institute, Imperial Institute, South Kensington, London, S.W.7.

SCIENTIFIC INSTRUMENT MAKERS (2, one supervisory grade and one grade I), and a LABORATORY STEWARD (supervisory grade)—The Professor of Physics, Birkbeck College, Breams Buildings, London, E.C.4.

PHYSICAL CHEMIST and a BIOCHEMIST—The Director of Research, Research Association of British Flour Millers, Cereal Research Station, St. Albans, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 63: The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds, Part 9. The Primary Thermal Oxidation Product of Ethyl Linoleate. By J. L. Bolland and H. P. Koch. Pp. 4. (London: British Rubber Producers' Research Association, 1945.) [1912]

Is It Nothing to You? By Victor Gollancz. Pp. 16. (London: Victor Gollancz, Ltd., 1945.) 4d. [1912]

Association of University Teachers. Report on University Developments, Part 3. Comprising the Universities and the Education of Teachers; The International Functions of a University. Pp. 8. (Bristol: J. W. Arrowsmith, Ltd., 1945.) 1s. [1912]

Ministry of Supply. A First Guide to Quality Control for Engineers. Pp. 38. (London: H.M. Stationery Office, 1945.) 1s. net. [1912]

A. Sc. W. Memorandum. Trades Union Congress, Blackpool, September 1945: Delegates' Report. Pp. 16. 3d. Information Leaflet No. 1: Executive Statement on the Atomic Bomb. Pp. 4. (London: Association of Scientific Workers, 1945.) [1912]

Chelsea Polytechnic, 1895–1945. Pp. 8. (London: Chelsea Polytechnic, 1945.) [1912]

Physical Society. Catalogue of the Thirtieth Exhibition of Scientific Instruments and Apparatus, January 1946. Pp. 288 + lxxxviii. (London: Physical Society, 1946.) 2s. net. [1912]

Other Countries

Northern Rhodesia. Report on the Development of Secondary Industries in Northern Rhodesia. By Dr. W. J. Busschau. Pp. 91. (Lusaka: Government Printer, 1945.) 2s. 6d. [2211]

Geological Survey of Uganda. Water Supply Paper No. 1: Water Boring in Uganda, 1920–1940. By C. B. Bisset. Pp. 32. Water Supply Paper No. 2: Small Reservoirs in Uganda. By C. B. Bisset. Pp. 44. 2s. 6d. (Entebbe: Government Printer, 1945.) [2211]

Museums Trustees of Kenya. Annual Report for the Year 1944 of the Museums Trustees of Kenya and of the Coryndon Memorial Museum, Nairobi. Pp. 7. (Nairobi: Coryndon Museum, 1945.) [2211]

Yale University School of Medicine. Fifth Annual Report of the Historical Library, June 30, 1945. Pp. 34. (New Haven, Conn.: Yale University School of Medicine, 1945.) [2211]

Cawthron Institute. Annual Report, 1944–5. Pp. 31. (Nelson, New Zealand: Cawthron Institute, 1945.) [2211]

Survey of India. Civil Activities Report, War Period (1939–45 up to 31.3.45.). Pp. 10. (Dehra Dun: Survey of India, 1945.) [2211]

Supplement to the American Ephemeris, 1946: Tables of Sunrise, Sunset and Twilight. Pp. 196. (Washington, D.C.: Government Printing Office, 1945.) 75 cents. [2211]

Acta Pharmacologica et Toxicologica. Vol. 1, Fasc. 1. Pp. 128. Vol. 1, Fasc. 2. Pp. 129–224. (København: Einar Munksgaard, 1945.) 35 kr. per Vol. (4 parts). [412]

Carnegie Corporation of New York. Report of the President, the Secretary and the Treasurer for the Year ended September 30, 1945. Pp. 71. (New York: Carnegie Corporation, 1945.) [1312]

Union géodésique et géophysique internationale. Travaux de l'Association Internationale de Géodésie. Tome 15, Fascicule 1. 15 rapports. (Paris: Association Internationale de Géodésie, 1939.) [1312]

Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1940. Pp. lii + 104 + 4 plates. Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1941. Pp. xxxvi + 188 + 5 plates. (Bern: Paul Haupt, 1941–1942.) [1312]

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft. 120 Jahresversammlung vom 28 bis September 30, 1940 in Locarno. Pp. 524 + 54 + 11 plates. 121 Jahresversammlung vom 6 bis 8 September 1941 in Basel. Pp. 438 + 16 plates. (Aarau: H.R. Sauerlander et Cie., 1940–1941.) [1312]

University of Bombay: Department of Chemical Technology. Annual Report, 1944–45. Pp. iv + 43. (Bombay: University of Bombay, 1945.) [1312]